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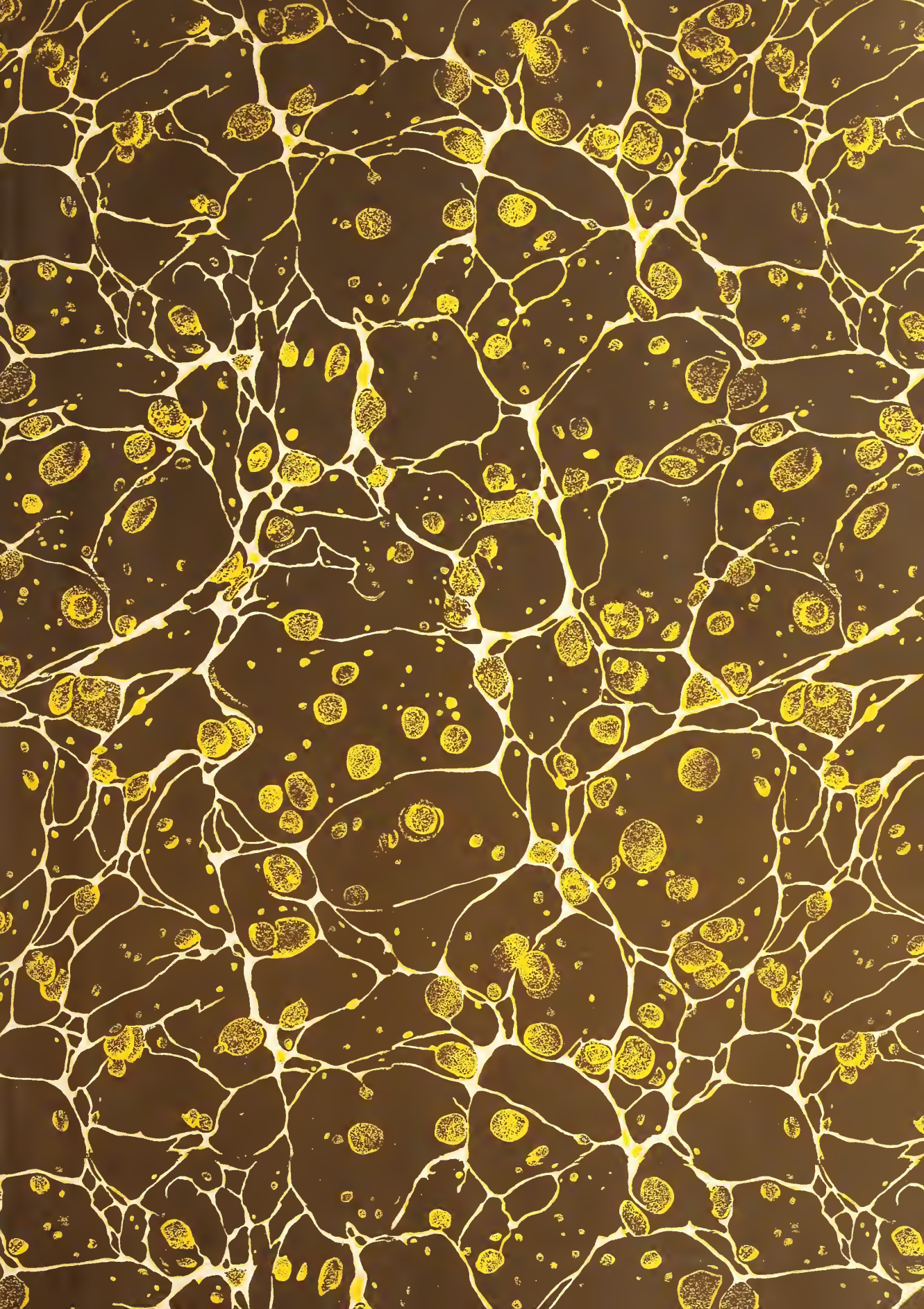
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RECOMMENDATIONS FOR SHIPPING CAGES FOR BEES

by

Warren Whitcomb, Jr., Assistant Apiculturist,
Bureau of Entomology, United States Department of Agriculture 1/

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1/ The Southern States Field Station of the Division of Bee Culture Investigations of the Bureau of Entomology is located at Baton Rouge, La., and is maintained cooperatively by the Louisiana State University and the United States Department of Agriculture.

INTRODUCTION

As a result of a study carried on by the Southern States Field Station of the Division of Bee Culture Investigations of the Bureau of Entomology, covering various types of cages which have been or are now in use for shipping nuclei and package bees, the following recommendations are being made concerning the construction of such cages, with the idea of establishing general standard types embodying the best features of the cages studied. This work has been facilitated by the active cooperation of shippers and purchasers of package bees and nuclei with the Southern States Field Station. The American Railway Express Company has also cooperated in this work.

There have been used, since the World War, at least 70 distinct sizes and types of shipping cages for bees. The tendency during recent years has been toward fewer types of cages as well as fewer cages of each type. The demand for combless cages is largely confined to the 2 and 3 pound sizes with indications that the 3-pound size will replace the 2-pound cage except in shipments to Canada. For this reason, in this paper, the number of cage sizes has been reduced to a minimum and an attempt made, by incorporating the best features from several cages, to limit the cage design to a single, well-constructed cage.

CAGE TYPES 2/

The cages used for shipping bees may be divided into three distinct type classes - the combless cage, the comb cage, and the nucleus cage. For the purposes of this paper they are defined as follows:

1. The COMBLESS cage is a shipping container for bees which is designed to hold one or more pounds of bees, without combs, and, as food, a sirup of granulated sugar, no honey being used.

2. The NUCLEUS cage is a shipping container for a nucleus of bees consisting of one or more frames of brood and honey with adhering bees.

3. The COMB cage is similar to the nucleus cage except that it will contain one or more additional pounds of bees.

THE COMBLESS CAGE

GENERAL

The combless cage is adapted to the shipment of bees without combs, and provided with a food made of granulated sugar and water. For many years, different sizes of combless cages were used for shipping different quantities of bees. Thus there was an individual cage for the 2-pound package, which ranged in size from 16 inches by 9 inches by 6 inches to 12 inches by 8 inches by 5 inches, and an individual cage for the 3-pound package, which ranged from 17 inches by 9-1/2 inches by 6-1/2 inches to 14 inches by 8 inches by 6 inches. For the past few years the tendency among shippers has been to make the 2 and 3 pound combless cages more nearly of

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2/ A distinction is made between "cage" and "package" in these recommendations. The "cage" is the container in which bees are shipped. The "package" is the cage with food and bees ready for shipment.

the same size, until at the present time many shippers are using the same size cage for both 2 and 3 pound combless shipments, supplying two pounds of food for 2-pound shipments and three pounds of food for the larger size. By this method only one size of cage and feeder need be kept in stock.

CONSTRUCTION

Dimensions. The outside dimensions recommended for the combless cage are: length, 16 inches; height, 9 inches; width, 5-1/2 inches.3/

Lumber. The lumber used in combless cages should be light, strong, straight-grained, and free from knots. The boards should be three-eighths inch in thickness and planed on one side only, since the rough unfinished surface on the inside of the cage allows the bees to cling to them more tightly. The end strips for holding on the wire screening should be fastened by one nail to the top, one to the bottom, and two to the ends of the cage as shown in the illustrations (Figs. 1, 2, and 3).

Nails. The nails used in cage construction, except those used in securing the cover over the feeder can, should be cement-coated and not less than 1-1/2 inches in length. The nails used in securing the cover over the feeder can need not be more than three-quarters inch in length.

Screening. The cages are screened on the two 16 by 9 inch sides. The screen should be the ordinary black wire screen-cloth with 12 meshes to the inch. The screens should be cut to fit, stretched tightly, and well tacked in place. They should not project beyond the wood. Wooden screen strips not more than one-fourth inch in thickness should be nailed over the edges of the screen, using cement-coated nails not less than one-half inch in length. To prevent the screening from bulging out in the center of the cage, another wooden strip of like thickness and extending from the top to the bottom screen strip may be used on each side. (See figs. 2 and 3.)

Specifications for parts for combless cage. For the construction of the combless cage, the following materials will be necessary:

1 top	16"	x 5-1/2"	x 3/8"
1 bottom	16"	x 5-1/2"	x 3/8"
2 ends	8-1/4"	x 5-1/2"	x 3/8"
4 screen strips	14-1/2"	x 3/8"	x 1/4"
4 screen strips	9"	x 3/4"	x 1/4"
2 screen strips	8-1/2"	x 3/8"	x 1/4"
1 feeder hole cover	5"	x 4-1/2"	x 1/4"
2 pieces screening (sides)	16"	x 9"	

Nails as described in text.

3/ Ordinary finished 6-inch boards average slightly more than 5-1/2 inches in width. For the purpose of these recommendations, where 5-1/2-inch lumber is specified, finished 6-inch boards will be satisfactory.

The additional material required for the recommended cluster devices and feeder can supports of the combless cage will be found in the description of these cage furnishings as given later.

Feeder can. The feeder can used in the combless cage should be the No. 3 friction top can holding about three pounds. There is some slight variation in the dimensions of the cans supplied by various manufacturers owing to the different methods of soldering and sealing, but the capacity is approximately the same for all No. 3 cans. Two holes, one thirty-second inch in diameter, should be punched inward within one-half inch of each other near the center of the can lid for 2-pound shipments and three holes of the same dimensions and similarly placed for the 3-pound shipments. These are easily and accurately punched with the aid of a one thirty-second inch drill placed in a drill chuck. A tap with a hammer forces the drill through the cover of the can and a quarter turn reams the rough edges from the hole. The drill should extend only about one-fourth inch from the jaws of the chuck to avoid breakage of drills. By using this method the holes in the feeder-can lids may be punched after the cans have been filled with sirup.

Feeder-can support. The feeder can support used in the combless cage is very important and must hold the can securely when the cover is nailed to the cage. Two types are recommended:

(1) A combined can support and cluster device (Fig. 1) described under the heading "Cluster Device."4/

(2) A support constructed in the form of the letter "H". (Fig. 4.) This type is made of two uprights each 8-1/4 inches long, 1 inch wide and one-half inch thick. They are joined by a cross-bar which should be 1 inch wide by one-half inch thick by 5 inches long, and mortised to a depth of one-fourth inch into the uprights, and securely nailed. There will be a slight variation in the height at which the cross-bar is placed owing to the slight variation in the cans made by different manufacturers. The cross-bar should be placed at such a height that the top of the feeder can is just flush with the top of the cage, and in contact with the cover when it is nailed in place. The hole in the top of the cage, through which the feeder can is inserted, should be very slightly larger than the feeder can so that it may be easily inserted and removed. When the cover is nailed over the can, the feeder is prevented from moving in any direction within the cage.

Food. The food used in combless packages should be composed of one part by weight or volume of granulated sugar dissolved in one part by weight or volume of water. The sugar may be dissolved in cold water. The sirup should be strained through two thicknesses of cheese cloth to remove any undissolved

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4/ This type of can support was devised in 1930 by Mr. M. J. Deyell of the A. I. Root Company. This company has generously granted permission to describe the device in this circular, thus making it available to the public.

The other types of feeder-can supports and cluster devices have been in use some time and so no attempt is being made to render individual credit for them.

granules of sugar, or any foreign matter, before placing the sirup in the feeder cans. The feeder cans should be filled just before the time of shipment. One pound of sirup is sufficient food for one pound of bees in all ordinary combless shipments.

Cluster device. Three types of cluster device are recommended, choice as to the particular type being left to the package shipper. These types are:

(1) a combined cluster device and feeder-can support;
(2) a cluster device of wooden strips; and
(3) a cluster device of wire screening.

(1). The combined cluster device and feeder-can support (see Fig. 1) is made of a single piece of one-quarter inch wood placed on edge diagonally across the bottom of the cage and extending all the way from corner to corner. This strip is held upright by the angle formed by each end of the cage and the attached screen strip. The width of this piece is just sufficient to hold the top of the feeder can flush with the top of the cover of the cage when the can is in position and resting on this piece. In such case the can is in contact with the cover for the feeder-can hole when this cover is nailed in place. If these conditions are met the feeder can is held firmly in place.

When this type of cluster device is used a strip of wood 8-1/4 inches long, 1 inch wide, and one-half inch thick may be nailed to the top and bottom of the cage on each side flush with the edges mid-way between the ends. This will serve to hold the screen out and make the top firm enough to nail on the feeder-hole cover.

(2). The cluster device of wooden strips (Fig. 2) consists of four wooden strips each approximately 17-1/2 inches long, seven-eights inch wide, and one-eighth inch thick, two of which extend diagonally across the cage from the top on one end to the bottom on the other, while the other two extend from the top of the opposite end to the bottom on its opposing end. Each strip alternates with one running in the opposite direction, thus forming two pairs of X's side by side.

(3). The cluster device of wire screening (Fig. 3) is made from a single piece of screen 2-1/2 inches wide nailed beneath wooden strips at the top of the cage at a distance 2 inches from the ends of the cage, and held at the bottom beneath a wooden bar nailed between the uprights of the feeder support. This piece of screening will be approximately 21 inches long. Care should be taken that the ends of the screen strip are securely nailed with cement-coated nails at the top of the cage to prevent the cluster device from pulling loose during shipment.

Queen cage. The queen cage shipped in the combless package should be the regular three-hole mailing-cage as supplied by commercial manufacturers. The cage should be suspended by a wire wrapped around the candy end of the cage at a distance from the end not exceeding one-third of the total length of the cage. It should be suspended through the feeder-can hole of the shipping cage at a height not lower than the lower edge of the feeder can. It is better that

the candy end of the cage, as suspended in the package, be slightly lower than the remainder of the cage to prevent the queen from becoming mired in the candy, although dead bees may sometimes clog the entrance to the candy. The wire used in suspending the queen cage may be the ordinary frame wire, 30 inches long, doubled, and securely wrapped around the queen cage. The outer ends of the wire should be wrapped once around a small tack in the top of the package, so placed that it will be beneath the wood cover of the package when ready for shipment.

Queen-cage food. One cell of the queen-cage block should be filled with candy, which is firm enough to prevent it from runng in the cage during transit. A cork stopper should be firmly pressed into the hole in the candy end of the cage, and the perforated metal strip securely nailed over the entrance hole at the opposite end of the cage.

Many shippers are successfully shipping combless packages in which the queens are contained in mailing cages without food. This practice will probably be more widely adopted in the future. It is claimed that there is less supersedure of queens when this method is used. The queens should be placed in the package soon after being caged so that the bees may feed them.

Queen-cage attendants. About ten attendant bees are sufficient for shipping with the queen in the queen cage.

Weight of bees. It is recommended that not less than 20 per cent overweight be allowed for each pound of bees shipped in combless packages, in order to assure full weight of bees at destination. Most shippers allow 25 per cent over-weight in order to offset loss of weight during shipping. All bees should be weighed rather than measured.

THE NUCLEUS CAGE 5/

Identical recommendations are made for the nucleus cage and the comb cage. These are given under the heading, "The Comb Cage."

THE COMB CAGE 5/

GENERAL

The comb and nucleus cages have gradually decreased in favor for the past few years, owing, partly at least, to bee-disease inspection laws, although the demand for a special cage for supplying bees for orchards has tended to revive this cage type. The 1-frame nucleus or comb cage has largely passed from existence except for a limited use for the shipment of valuable queens.

Two sizes of this cage are ordinarily used, the 2-frame nucleus or comb cage, and the 3-frame nucleus or comb cage. At the present time the 3-frame size is the more commonly used. The 3-frame comb cage or nucleus cage recommended here is also suitable for a 2-frame comb or nucleus shipment.

5/ See definitions on page 2.

The following recommendations cover not only the size of package but also the type of combs to be sent.

CONSTRUCTION

The comb cages are so designed that two or more frames are rigidly held in place during shipment, to prevent crushing of bees, and yet to allow the bees freedom of movement about the frames. The accompanying illustration (Fig. 5) shows the general features of comb-cage construction, the method of holding the frames in place, and the method of screening to provide ventilation.

Dimensions. The outside dimensions recommended for the comb cage are, - length, 19-3/4 inches; height, 12 inches; width, 5-1/2 inches.

Specifications for parts for the comb cage. The following materials will be necessary for the construction of the 3-frame comb cage:

2 ends	11-1/4" x 4-3/4" x 3/8"
4 sides	19-3/4" x 3" x 3/8"
2 tops and bottoms	19-3/4" x 4-3/4" x 3/8"
4 outer screen strips	6" x 3/8" x 3/8"
4 inner screen strips	19" x 3/8" x 1/4"
2 blocks on cover to hold frames down	4-1/2" x 1/2" x 1/2"
2 notched pieces to hold ends of frames	4-3/4" x 1-3/4" x 1/2"
1 notched piece to hold frames at bottom of cage	4-3/4" x 1-3/4" x 1/2"
2 screens	19-3/4" x 7"

Lumber. The lumber used in comb-cage construction should be three-eighths inch in thickness, strong, light in weight, straight-grained, and free from knots. The frame supporting strips at the ends and the bottom of the cage should be not less than one-half inch in thickness to prevent splitting of the notches in which the frames are held. These strips should hold the top of the frames not farther than seven-eighths inch from the top of the cage. The two pieces on the inner side of the ends of the cover should be one-half inch in thickness. The boards which form the top, bottom, side-strips, and ends of the cage should be finished on one side but the inner side of the cage is better if left unfinished.

Nails. The nails used in comb-cage construction should be cement-coated. Nails not less than 1-1/2 inches in length should be used for holding the top, bottom, sides, and ends together, and nails of not less than 1 inch in length should be used in nailing on the screen strips. The nails which secure the wooden frame holders at the ends of the cage should be clinched to prevent the weight of the frames from pulling the pieces loose during shipment.

Screening. The screen used should be the ordinary black screen-wire with 12 meshes to the inch. The screen should not be more than 6 inches wide, placed equidistant from the top and bottom of the cage, well tacked in place, and further secured with wooden screen strips not less than one-fourth inch in thickness. The screen strips placed inside the cage at the top and bottom of the screen need not be more than one-eighth inch in thickness. Care should be taken that the edges of the screen do not project beyond the wood.

Combs. The combs used in comb packages should be old combs, in which one or more generations of bees have been reared. New combs will not survive ordinary shipment without breakage. All brood should be sealed at time of shipment, since unsealed brood rarely is received alive at destination and since there is also the possibility that the bees may attempt to rear queens in transit. The frames should be wired, and the combs should be well attached to the wood to prevent breakage of combs during shipment.

Honey. Each comb package should contain not less than 1 pound of honey for each pound of bees shipped.

Sealed brood. The amount of sealed worker brood should average not less than 100 square inches per frame. For the 3-frame comb cage this would make at least 300 square inches of sealed worker brood. In the 3-frame comb cage it is best to place the frame containing the most brood in the center of the cage so as to protect as much brood as possible from chilling. The center comb may be nearly full of sealed brood, most or all of the necessary honey being contained in the two outer frames.

No frame should contain more than 5 square inches of drone cells at the time of shipment.

Queen cage. If the queen is caged for shipment in a comb package, the cage should be placed with its screen face down, across the tops of the frames. The blocks, one-half inch in thickness, which are nailed on the inner side of the cover near the ends, hold the cover above the frames and allow the bees to surround the queen cage. The pressure of the cover when nailed in place prevents the queen cage from moving about.

Queen-cage food and attendants. It is not necessary to place candy, or attendant bees, with the queen unless the queens are caged for a period before they are placed in packages.

Weight of bees. It is recommended that not less than 20 per cent overweight be allowed for each pound of bees shipped in comb packages, in order to assure full weight of bees at destination. Most shippers allow 25 per cent over-weight in order to offset loss of weight during shipment. All bees should be weighed rather than measured.

CRATING OF PACKAGES

When two or more cages are sent to the same purchaser, they should be crated together. The cages should be spaced 4 inches apart in the crate, with the crating strips extending at least 1 inch beyond the end cages. It is recommended that three cages be crated together. (Fig. 6.) If two cages are to be crated, the same length of crating strips should be used with the two cages occupying the same positions as cages number 1 and 3 in the three-cage crate. (Fig. 7.) By this method all crates whether of two or three cages may be stacked by the express handlers and still allow plenty of ventilation. By allowing the crating strips to project an inch beyond the end cages, it is

impossible to place the cage closer than 1 inch from the side of the car or from other shipments. The crating strips should be attached to the cages with cement-coated nails not less than 1-1/2 inches in length. Ordinary plasterers lath makes good crating material.

It is to be noted that no special provision is made for crating single packages. Any number more than three can be split into crates of twos and threes.

INFORMATION FOR EXPRESS HANDLERS

Bees in shipment should not be placed near steam heat or exposed to the sun.

The volume occupied by the recommended comb and combless cages shipped singly and the volume of the same cage types shipped in crates of three cages is as follows:

Cage type:	Single cage:	Crate of three cages:
Combless cage	797 cu. in.	2 cu. ft.
Comb cage	1,248 cu. in.	3-3/4 cu. ft.

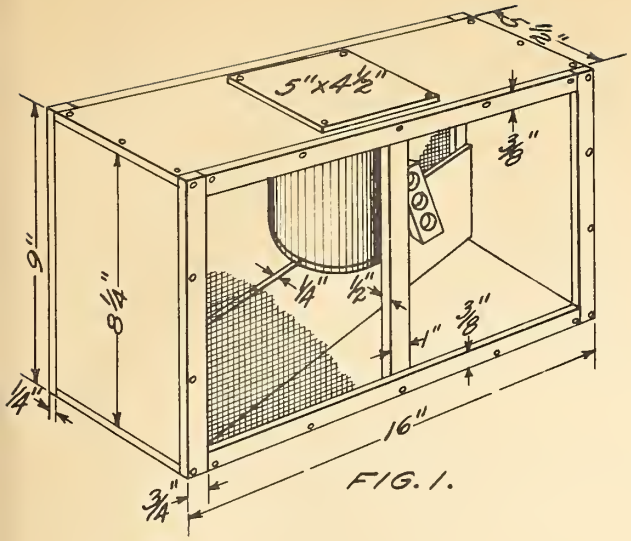


FIG. 1.

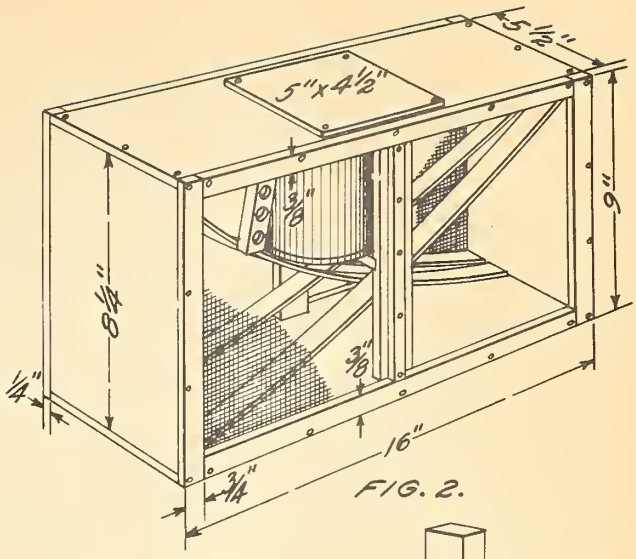


FIG. 2.

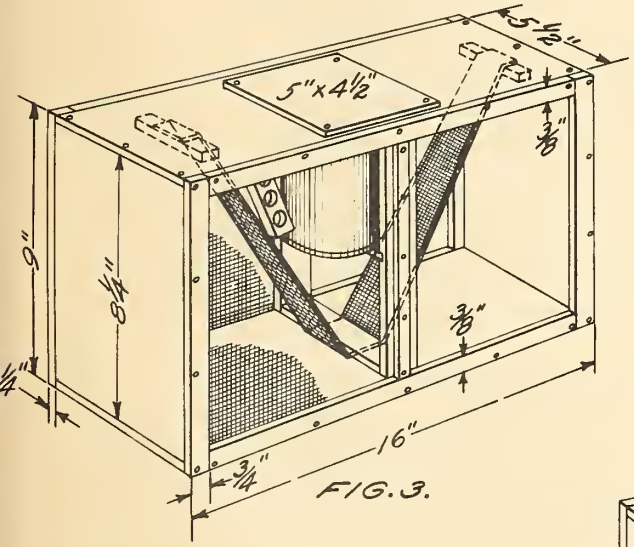


FIG. 3.

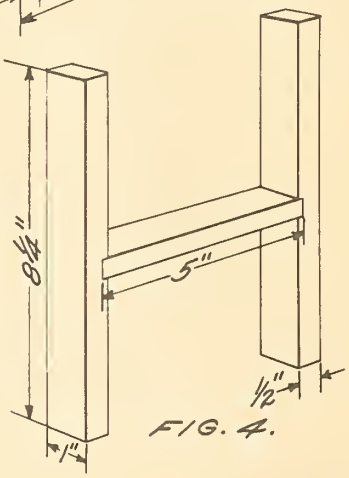


FIG. 4.

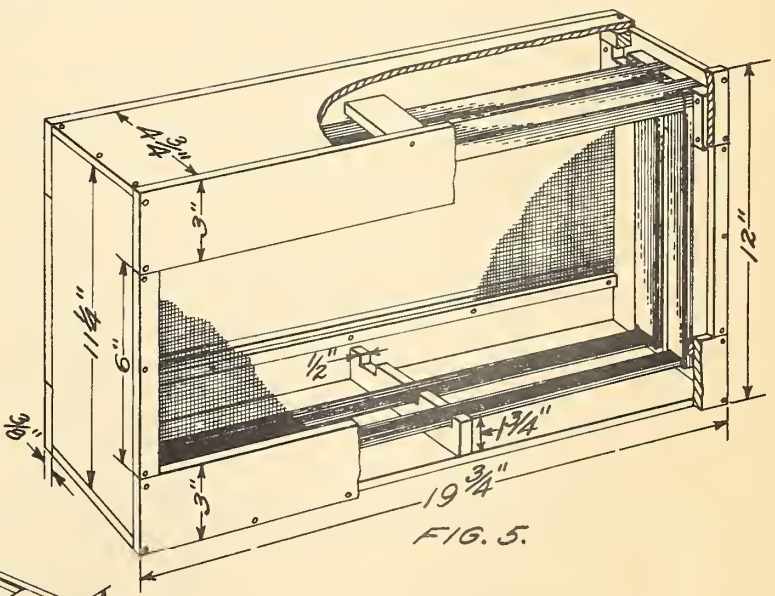


FIG. 5.

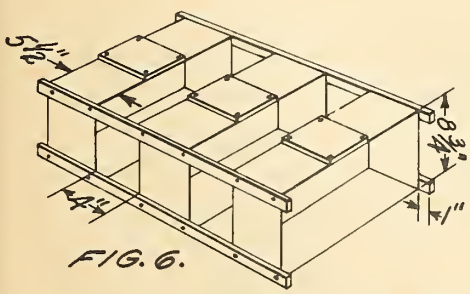


FIG. 6.

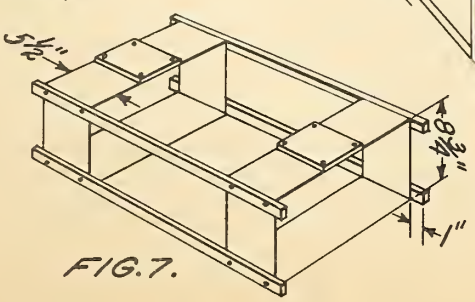


FIG. 7.

E-363 December 1935

United States Department of Agriculture
Bureau of Entomology and Plant Quarantine

THE SHIPPING OF PACKAGE BEES 1/

By Warren Whitcomb, Jr., Assistant Apiculturist, 2/
Division of Bee Culture 3/

The package-shipping industry began in the early eighties when A. I. Root, of Medina, Ohio, first shipped small screened cages containing one-half to 1 pound of bees. The bees were shipped with candy food and the cages were supplied with water feeders in most cases. This method of shipping bees attracted much attention, but the losses in shipment were large and the practice was soon abandoned.

During the World War commercial beekeeping received a great impetus, and with the increase of commercial honey production in the Northern States there came a demand for package bees from the South to be used to replace winter losses in the North or for increasing the number of producing colonies. The commercial bee-shipping industry really dates from about 1913 and made very rapid strides from that time until 1921, when a peculiar set of conditions brought about a lowering of the price for bees with a consequent decrease in the number of shippers.

Throughout the period from 1913 to 1918 a large proportion of the bees were shipped on candy food. Owing to several factors, perhaps chiefly because of the cost and lack of uniformity of the candy, the practice of shipping bees on candy decreased in favor, and in 1928 only one commercial shipper was using candy as a shipping food. Today practically all packages are shipped on a liquid food composed of approximately equal parts of granulated sugar and water.

In 1928 and, although accurate figures are not available, probably prior to that time, losses in shipments of bees averaged from 10 to 15 percent of all the bees shipped in packages. At that time a survey of shipping practices in

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1/ Data taken from a report covering the experimental shipments of bees made under the cooperative agreement between the Railway Express Agency and the United States Department of Agriculture. Contribution from the Southern States Bee Culture Field Laboratory, University Station, Baton Rouge, La.

2/ The writer wishes to express his sincere appreciation of the cooperation, courtesy, and information so freely given by the officials, agents, and messengers of the Railway Express Agency, without which this work would have been impossible.

3/ The Southern States Field Laboratory of the Division of Bee Culture of the Bureau of Entomology and Plant Quarantine is located at Baton Rouge, La., and is maintained cooperatively by the Louisiana State University and the United States Department of Agriculture.

the Southern States showed that about 80 different sizes, shapes, and designs of cages were being used for commercial shipments. In 1931 a multigraphed circular, E-287, "Recommendations for Shipping Cages for Bees", was issued by the Southern States Bee Culture Field Laboratory of the Bureau of Entomology, U. S. Department of Agriculture, and the recommendations were so closely followed by the majority of shippers that in 1933 practically only two types of cages were used in commercial shipments. For the 2-pound packages the cages are either 12 by 9 by 6 or 16 by 9 by 4½ inches, and for the 3-pound packages the cages are either 15 by 9 by 6 inches or 16 by 9 by 5½ inches. During the period from 1928 to 1933 the loss in shipment dropped to less than 1 percent, probably owing to three factors, the adoption of more standard cages, better preparation of packages by shippers, and better handling by common carriers.

The package-shipping industry has kept pace with the expansion of the commercial honey-producing industry and has grown from practically nothing in 1913 to a business requiring the full attention of nearly 200 commercial shippers. The following tabulation showing the volume of business during 1932 and 1933 is probably more accurate than any previous tabulation.

Year	Packages shipped	Pounds of bees shipped
1932	71,843	179,608
1933	88,180	190,450
1934	108,339	257,001

The following figures, furnished by the Railway Express Agency, show the amount of claims paid by the Agency on bees shipped in 1933. The figures are for claims paid and do not represent the total loss in shipment, since many shippers do not file claims for small losses.

Period	Number of claims	Total value	Average claim
4/1 - 4/15	6	$61.31	$10.21
4/16 - 4/30	8	30.12	3.76
5/1 - 5/15	22	120.99	5.50
5/16 - 5/31	23	195.18	8.49
6/1 - 6/15	31	620.01	20.00
6/15 - ... 1/	19	623.83	32.83

From this tabulation it is evident that the number of claims per half-month increased as the season advanced, but decreased slightly at its close; it is further evident that both the total value of losses and the average cost per claim for the first half-month were moderate, that in the second half-month they dropped to the low points for the season, and that thereafter they rose steadily to the end of the period reported.

The question of loss in shipment is one that concerns not only the carrier but also the shipper and the receiver of the bees. To the carrier, loss during shipment not only entails loss in revenue, but also engenders a lack of confidence in the service rendered. This has been shown during the past two years (1933-1934) in an increasing use of trucks coming from the honey-producing areas to the South and returning with loads of bees. In spite of express

1/ Last shipment claim on July 24.

rates being considerably lower than in the past, the trucking practice is satisfactory to the honey producer, since he personally supervises the transportation of the bees. This practice will be more satisfactory if he can develop a honey market in the South that will permit him to make use of his truck on the southward trip. To the shipper, who guarantees safe delivery of bees to destination, the loss during shipment means sending more bees, perhaps during a rush period when all of his time should be given to regularly booked orders, and in many cases means the loss of a customer. To the honey producer, loss in shipment means the loss of at least two weeks when bees should be building up to colony strength for a honey flow, and, if replacements are delayed, it may mean the total loss of a crop of honey.

In many ways the Railway Express Agency, with its far-reaching facilities, furnishes an ideal service for the shipping of bees. Trucks, with their personally interested attendants versed in methods of handling bees, may be able under adverse conditions to deliver bees in better condition, but the irregularity of schedule and the necessity for the shipper to prepare larger orders on short notice does not make this method of shipment particularly attractive to the shipper. Small orders are sent by mail, particularly to those places not served by other common carriers, but the vast majority of bee shipments are still carried by express.

During 1933 and 1934 losses in shipments of bees by express reached a high point similar to the losses prior to 1930. These losses were not confined to any one important express route or to any specific group of shippers or method of shipment. During April 1934 the writer was able to spend nearly three weeks in travel by automobile through the States of Louisiana, Mississippi, Alabama, and Georgia for a study of shipping methods. In most cases shippers are preparing bees in better shape for shipment, and with greater uniformity, than was observed on a similar trip in 1929.

The period from June 11 to July 19, 1934, was largely spent in travel with experimental shipments of bees from Natchez, Miss., to Lansing, Mich., to Hallock, Minn., and to Alice, N. Dak. Twenty 2-pound packages of bees were used in each shipment. These shipments allow some interesting conclusions to be drawn.

RESULTS OF EXPERIMENTAL SHIPMENTS

Handling by express messengers

The express messenger is a busy man even when shipments of bees are not heavy. It is his duty to receive shipments at receiving points, to keep accurate record of all shipments, to deposit shipments at destination, and to keep the shipments in his care in good condition. Messengers are interested in bees and, in my experience, give them as good attention as their information permits.

The diagram in figure 1 shows the average express car, with the heavy arrow indicating the direction of travel and the letters A, B, C, D, E, and F indicating the various loading areas within the car. In the diagram the doors in the sides of the car are shown open while those in the ends of the car are closed.

Spaces A, B, C, and D are suitable for bees, since they are well ventilated with the exception of the rear corners of the car. Spaces E and F are never well ventilated and bees are not carried there. Spaces A and B are usually occupied by the express messenger and the equipment necessary for his work, so that little of this space is available for bee shipments. Spaces C and D therefore are the best and most frequently used areas for package-bee shipments.

In these areas, C and D, the express messenger must stack all the package bees received on his particular run. Perhaps no two shipments are crated alike or in the same size packages, but the messenger is responsible for providing this miscellaneous assortment with adequate ventilation. In addition to this, at the end of his run, the messenger turns the bees over to a second messenger, who must check shipping point, waybill number, and destination on each shipment and rearrange the shipments to best advantage for unloading. Under such conditions the express messenger is doing a very creditable job of carrying bees safely to destination.

Effect of the sun

Sun will kill bees; however, the death of package bees exposed to the sun is not caused by the effect of the sun's rays but by the high temperature which this exposure causes within the package. Under normal conditions of temperature and ventilation the honeybee spends a good part of its active life fully exposed to the action of the sun. When bees are caged, however, there is less ventilation and more nervousness and activity. As the temperature rises, from exposure to sun, the activity within the package increases, and with the increase in activity there is a corresponding rise in the temperature within the package due to the increased activity. Unless there is adequate ventilation to carry off the excess heat, a package of bees may die within 30 minutes. However, the sun is merely an activating agent and not a killing agent.

No losses occur to packages of bees exposed to the sun if given adequate ventilation, as was shown in the experimental cages exposed to sun for periods of 5 to 7 hours. There is seldom any loss from sun when a single package of bees is exposed, but when a truck load of bees is exposed, even for a short period, there is a likelihood that those packages which are cut off from ventilation by surrounding packages may die rapidly from high temperatures plus poor ventilation even though the direct rays of the sun cannot penetrate to them.

Effect of high temperature

Bees in a screened cage, either with or without a queen, are always more nervous and exhibit more activity than similar bees on combs. Activity with bees generates heat, and in a screened cage this heat is generated rapidly. High temperature, that is, a temperature ranging from 85° to 105° F., tends to increase the activity of bees and this activity in turn further raises the temperature and also increases the consumption of food. At temperatures of 70° F. or less, with adequate ventilation, package bees will be quiet and loosely

clustered, and this condition is maintained unless temperatures below 50° F. are encountered. Such low temperatures would be rarely found in an express car but might be encountered at transfer points. Even at transfer points, if a large shipment was being handled, the heat generated by the bees would tend to keep the cage temperatures considerably higher than the surrounding temperature. It must be remembered that bees can stand low temperatures during shipment much better than they can stand high temperatures.

Effect of ventilation

As stated above, the effect of high temperatures can be offset by adequate ventilation. The crowding of bees in screened cages tends to cut down the free movement of air. During the hot weather, or when for any reason the bees are active within the cage, free circulation of air is necessary to carry off the heat and to prevent it from accumulating within the cage. Bees can survive with very little ventilation when the temperatures are low, as shown in shipments when normal ventilation was cut off by surrounding express shipments. However, when bees are exposed to sun with the accompanying high temperatures, ventilation is extremely important, as shown by the fact that the bees in the center cages in a crate died when exposed to sun while those in the better ventilated end cages of the crate survived.

In large shipments, with carload lots, or when cars are heavily loaded with other express shipments, the ventilation of the car is poor even with all the doors open. In such cases those packages located at the bottom of the stack and near the side walls of the car fail to receive adequate ventilation, high temperatures result, and the bees die.

Effect of ice

In tests with package bees surrounded with cakes of ice the bees were quietly clustered during the entire period even though ventilation was apparently cut off. There was apparently no ill effect when the bees were brought back to normal car temperature. Temperatures between cakes of ice were from 52° to 60° F., but the temperatures between cages in the crate were from 76° to 82° F. Consumption of food under such conditions was low.

Effect of water feeding

Practically all express cars are equipped with ice-water dispensers, and ice water was used whenever bees were given water. The crate was placed on end and the ice water drizzled slowly through the screen. Usually two cups of water were given, and within five minutes the bees would be quiet and closely clustered. The effect of giving water was the same as lowering the temperature and probably served no other purpose. Messengers on the St. Paul division carry either brushes or spray guns for giving the bees water, and it seems likely that a more common use of water would be beneficial so far as quieting the bees is concerned.

HOW THE SHIPPER CAN HELP PREVENT LOSS IN SHIPMENT

Most shippers deliver their packages to the express office in good condition so far as the bees are concerned, but in many cases there is much to be desired from the shipping standpoint. In other words, the shipper puts up a good package which would probably arrive safely at destination if it were shipped alone, but it may be a poor package when shipped in a car with other shipments. There has been remarkable uniformity of package sizes and types for the past two years, but there is less uniformity of crating methods. The average shipper has studied his own business thoroughly, but he has given much less attention to the effect that other shipments may have on his bees.

Effect of screen

Two types of cages are now being used, those screened on two sides and those screened on four sides. Under most conditions there is little choice between the two types so far as shipping is concerned, but during periods of extremely high temperatures or under conditions such as have been prevalent throughout the Middle Western States for the past two years there may be a distinct advantage in using the cage screened on four sides. With an increase of temperature above 70° F., under normal ventilation, bees tend to leave the center of the cage and to hang on the screen. Under such conditions the cage screened on four sides offers more cluster space and consequently allows better ventilation.

Effect of cluster strips

In 1929 some experimental shipments showed that cluster strips, whether of wood or of screen, were of no value during shipment. The experimental shipments of 1934 and the limited observation of commercial shipments during the same period have tended to confirm this view. Even during periods of medium temperature, when the bees were loosely clustered, there was no evidence of jarring down of the cluster in cages where no cluster strips were used. It therefore seems evident that, so far as shipments are concerned, cluster strips have little or no value.

Effect of crating

The proper and uniform crating of packages (fig. 2) is an important factor in the successful shipment of bees, especially during periods of high temperature or when ventilation is poor.

The section on crating of packages in Circular E-287, "Recommendations for Shipping Cages for Bees," has been made more definite in order to help increase the uniformity of crating. The revised recommendations are as follows:

"When two or more cages are sent to the same purchaser, they should be crated together. Four crating strips each 34 inches long by not less than 1 inch wide and three-eighths inch thick should be used on each crate. Not more than three cages should be crated together. The end cages of the crate should be placed 2 inches from the ends of the crating strips and the

center cage placed midway between the two end cages. If two cages are to be crated, the same length crating strips should be used as with the 3-cage crate, with the two cages occupying the same positions as cages 1 and 3 in the 3-cage crate. By this method all crates, whether of two or three cages, may be stacked by the express handlers and still allow plenty of ventilation. When the crating strips are allowed to project 2 inches beyond the end cages, it is impossible to place the side of the cage closer than 2 inches from the side of the express car or from other shipments.

"It is to be noted that no special provision is made for crating single packages. Any number more than three can be split into crates of twos and threes."

This means that cages will be spaced at least 6 inches apart in the crate, which will allow ample circulation of air and help to insure the safe arrival of bees at destination, even during periods of high temperature. However, with this increase in the space between packages in the recommended crate it becomes increasingly important that all shippers use the same crating methods.

Further studies of commercial shipments of bees will be made during the year 1936. It is probable, however, that high temperature and inadequate ventilation are responsible for a great portion of the losses in shipment sustained during the last two years. It is also probable that more uniform crating methods and more uniform packages will greatly reduce this loss. Shipping methods which gave good results during the period from 1930 to 1932 will perhaps still prove adequate early in the shipping season when shipments are light and temperatures likely to be low, but they are not adequate during the rush of the shipping season and during periods of high temperature. Under such conditions the shipper must package and crate his bees in such a way that they can be stacked with other shipments in the express car and still allow adequate ventilation.

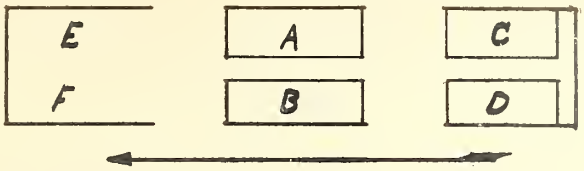


Figure 1.--Diagram for express car, showing areas (C and D) most suitable of those available for package bees.



Figure 2.--Bees crated for shipment. This type of crating allows adequate ventilation.

July 22, 1932.

Bee Culture

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAUS OF ENTOMOLOGY AND AGRICULTURAL ECONOMICS

UNITED STATES STANDARDS FOR EXTRACTED HONEY

GRADES

NOTE: – These grades supersede United States Standards for Extracted Honey issued in December 1927 and published in Circular No. 24.

United States Fancy shall consist of extracted honey of any color which meets the following requirements:*

1. The honey shall be clean (1), and free from damage (3) caused by turbidity (5), overheating, fermentation, honeydew, objectionable flavor or odor (6), or damage caused by other means.
2. The honey shall be well ripened and shall weigh not less than 11 pounds, 12 ounces per gallon of 231 cubic inches at 68 degrees F. (See tolerance, color, packing and marking, page 2)

United States No. 1 shall consist of extracted honey of any color which meets the following requirements:

1. The honey shall be fairly clean (2), and free from damage (3) caused by turbidity (5), overheating, fermentation, honeydew, objectionable flavor or odor (6) or damage caused by other means.
2. The honey shall be well ripened and shall weigh not less than 11 pounds, 12 ounces per gallon of 231 cubic inches at 68 degrees F. (See tolerance, color, packing and marking, page 2)

Unclassified shall consist of extracted honey which does not conform to the requirements of either of the foregoing grades.

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* The numbers in parentheses following certain words indicate that these words are defined under Definitions of Terms, page 3.

(OVER)

Tolerance.** - In order to allow for variations incident to proper grading and handling, not more than 5 per cent, by count, of the containers in any lot (graded as U. S. Fancy or U. S. No. 1) may have honey below the requirements for the grade, but no part of this tolerance shall be allowed for defects causing serious damage (4).

COLOR

Extracted Honey shall be classified as water white, extra white, white, extra light amber, light amber, amber, or dark according to the Standard Pfund color scale instrument. A closer description may be given by quoting the millimeter scale reading in addition to the color, e.g., light amber 6.2.

Tolerance.** - In order to allow for variations incident to proper grading and handling, not more than 5 per cent, by count, of the containers in any lot may have honey which varies from the color specified, provided that no tolerance is permitted for honey which shows a millimeter scale reading below the next color class.

PACKING AND MARKING EXTRACTED HONEY

Containers shall be strong, clean, and new in appearance. Each individual container of honey shall be marked with the grade and net weight and, if the honey is in an opaque container, the color shall also be marked.

In order to allow for variations incident to proper packing and marking, not more than 5 per cent, by count, of the containers in any lot may fail to meet these requirements.

**APPLICATION OF TOLERANCES. The tolerances specified for the various grades and color are placed on a container basis. However, any lot of honey shall be considered as meeting the requirements of a specified grade and color if no sample from the containers in any lot is found to exceed the tolerances specified by more than double the amount allowed, provided the entire lot shall average within the tolerances specified.

DEFINITIONS OF TERMS

As used in these grades:

(1) Clean means that the honey shall be at least as free from foreign material as honey which has been strained through standard bolting cloth of 86 meshes per inch at a temperature of not more than 130 degrees F.

(2) Fairly clean means that the honey shall be at least as free from foreign material as honey which has been strained through standard bolting cloth of 23 meshes per inch at a temperature of not more than 130 degrees F.

(3) Damage means any injury or defect which materially affects the appearance, edibility, or shipping quality of the honey, such as -

The presence of any objectionable flavor from floral source. Nectar gathered from plants such as bitterweed often imparts a very disagreeable flavor to the honey, which materially injures its quality.

(4) Serious damage means any injury or defect which seriously affects the edibility, or shipping quality of the honey.

(5) Turbidity means cloudiness caused by the presence of pollen grains, minute air bubbles, finely divided wax particles, or other substances which detract from the clearness of honey.

(6) Objectionable flavor or odor means any flavor or odor from floral source, taint of smoke, or other source, which materially affects the edibility of the honey.

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Bee Culture,

PRELIMINARY REPORT ON APIARY ORGANIZATION AND HONEY PRODUCTION IN THE INTERMOUNTAIN STATES IN 1928

Based on studies by the
Bureau of Entomology and the Bureau of Agricultural Economics
of the United States Department of Agriculture

By

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INTRODUCTION

This preliminary report shows the results of an economic study of honey production in Colorado, Idaho, Montana, Utah, and Wyoming during the season of 1928, under a cooperative agreement between the Division of Bee Culture Investigations of the Bureau of Entomology and the Division of Farm Management of the Bureau of Agricultural Economics, both of the United States Department of Agriculture[1]. This investigation included a study of methods of apiary management as well as a brief analysis of detailed records of labor used, cash expenses, and production, as kept by representative producers in the section.

Related economic studies dealing with present methods of marketing and an analysis of the consumer demand for honey have been made or are now under way. These studies, dealing with the marketing problems in the different sections of the United States, and the studies of honey production will be related when data from the various sections are available.

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[1] We take this opportunity to express our appreciation to Messrs. R. G. Richmond, Deputy, Apiary Inspection, Fort Collins, Colo.; C. L. Corkins and Charles W. Roe, University of Wyoming, Laramie, Wyo.; A. P. Sturtevant, Associate Apiculturist, United States Intermountain Bee Culture Field Station, Laramie, Wyo.; J. M. Starke, Middleton, Idaho; A. W. B. Kjosness, General Manager, Mountain States Honey Producers' Association, Boise, Idaho; D. H. Hillman, State Apiarist, Salt Lake City, Utah; J. C. Henager, President, Utah State Beekeepers' Association, Salt Lake City, Utah; and O. A. Sippel, State Apiarist, Bozeman, Mont., for their help in establishing the study and in carrying out the field work. Much credit is also due the beekeepers who gave of their time in keeping the daily records.

We also thank the beekeepers and beekeeping specialists of other States who offered assistance which we were unable to accept because of the limited funds available for 1928.

PROBLEMS OF MANAGEMENT

Apiary management and the effective use of such equipment as one has on hand--providing it is good equipment--appear to be important considerations in the economical production of honey. A comparison of the work of various beekeepers, observed at the time of four visits at important seasons of the year, plainly shows that one man may accomplish much more work than another, with no more effort, simply by arranging his work and the equipment he uses so that he may work effectively. As an instance of work done unprofitably one cooperator expressed his pleasure at having been furnished the necessary blanks for keeping accurate labor records of his work. He said that formerly, when visiting an out-apiary, if some little thing remained undone, or something was lacking to complete the work on some colony, he felt no hesitation about driving back to do that small item of work. "Now", he said, "if it isn't worth more than the $2.50 that it costs me to go back to do the work, it remains undone."

The value of accurate labor and financial records is evident. Unless the beekeeper knows whether this or that operation in his routine is of importance to him in dollars and cents, he may spend much time and money in doing something that is of little or no value while neglecting to perform some other operation which would bring him a good return. Without records, carefully studied, no man knows that he has not made mistakes in his plans or has wasted energy doing something he believed to be important to his success when, in reality, some other item, which he may have neglected, was the important one.

An instance of an unsettled problem is that of the use or non-use of queen excluders and bee escapes. Successful beekeepers advocate each method, some claiming that a queen excluder is also a honey excluder, while others believe they secure better yields when queen excluders are used. Some producers feel that a system of management using excluders and bee escapes which keeps the bees as gentle as possible has advantages which outweigh a possible small reduction in yield. Another problem on which more information is needed is the relative advantage of raising or of purchasing queens.

Such questions as these come up: What is the minimum in house and equipment that the beekeeper with a given number of colonies must have for best commercial results? What method of management is most economical of time for the results achieved? What are the things that it pays to do, both in dollars and in comfort of working? What can be left undone that might be done if only a few colonies were kept as a hobby? This report is made to answer such questions where the data obtained are sufficient to offer a solution, and in order that those who are concerned in these problems may work together most effectively. During this investigation in 1928 the Extension agencies of the various States, the bee press, beekeepers' organizations, and particularly the beekeepers themselves, gave excellent assistance, and we are assured of their continued help.

A total of 25,845 colonies were included in the apiaries on which complete records were obtained. Of these 18,633 were run for extracted honey, producing a total of 28,613 60-pound cans of extracted honey and 718 cases of comb honey. The

remainder, 7,212 colonies, run primarily for comb honey, produced a total of 26,199 cases of comb honey and 2,710 60-pound cans of extracted honey. Not all the data secured are sufficiently complete to be discussed in this preliminary report, but, with the continuation of the study as planned for several following years, more details necessary to successful operation of apiaries should be developed. Similar studies will also be made in other important honey-producing regions.

LOWER PRICES OF HONEY

REQUIRE CHANGES IN METHODS OF PRODUCTION

The Intermountain Region, as a whole, is one of the most important regions of the United States producing surplus honey. A very small proportion of the honey is sold locally, but most of it is shipped in car lots to eastern markets. Honey from the Intermountain Region has also been exported in considerable quantities.

The prices received for the bulk of the honey crop are indicated by Table 1, which shows average prices for car lots at the point of origin in this region. In 1923 and 1924 a price of about 9 cents per pound for extracted honey prevailed at the time the bulk of the crop was marketed. In 1926 the price had dropped to 6¾ cents per pound, and in 1927 it was near 7½ cents.[1] Sales in 1928 indicate prices that were a little lower than in 1927.

With most of the producers in this section the income of the operator is dependent on the returns from his apiaries. Years of low prices or low yields mean reduced income for the specialized beekeeper. As a sequel to the lowered prices of honey in recent years profits to producers have taken a corresponding decrease. Prices of comb honey as well as of extracted honey have dropped, and, having little or no opportunity to develop local markets, producers are forced to consider methods of reducing costs of production as being an important means of increasing net returns from their apiaries.

Table 1.--Prices paid for extracted honey in car lots at points in the Intermountain States in the months when most honey is sold[2]

Year	September	October	November	December
	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.
1921	7¾	7¾	8	8½
1922	8	8	8	8
1923	8	9	9	9
1924	9	9	9	9¼
1925	8½	8½	8½	8½
1926	6¾	6¾	6¾	6¾
1927	7	7½	7¾	7¼
1928[3]	7¼	7¼	7	7

[1]United States Dept. of Agr. Yearbook, 1927.

[2]United States Department of Agriculture Yearbook, 1927, p. 1059.

[3]Will appear in Yearbook for 1928.

In the wide range of methods and practices in use in this section some producers are making greater economies in the use of equipment and supplies than are other producers. Management which tends to increase the yield per colony without a corresponding increase in operating costs lowers the production cost per pound. This study, based on records from 39 beekeepers in the Intermountain States, shows the business organization of these producers, their items of expense, and the production obtained.

The honey crop of 1928 was very good in some parts of the Intermountain Region and extremely poor in others; as a whole, therefore, the records obtained in 1928 show the range of conditions likely to occur in any part of the region for a number of years to come.

NATURAL CONDITIONS

AFFECTING APIARY ORGANIZATION AND HONEY PRODUCTION

Beekeeping in the Intermountain States is limited to the irrigated sections. Alfalfa (particularly where it is grown for seed) and sweet clover are the important honey plants. In a few instances beekeepers grow sweet clover primarily for the use of bees, but more often the apiaries are located where honey plants occur. Confined to watered land and chance locations, good situations for apiaries are often widely scattered and the out-apiaries can not always be placed so as to make the best use of the operator's time for work and travel. Competition among beekeepers for locations, as well as changes in crops grown, may necessitate frequent shifts in the location of apiaries.

Although the sources of honey and the nature of the principal honey flow are fairly uniform throughout the area, other natural conditions are variable and necessitate changes in the organization of apiaries and in methods of caring for the bees. In addition to white sweet clover and alfalfa, some honey is obtained from yellow sweet clover, dandelion, and desert flowers. The early-blooming plants provide stores for building up colonies and increasing their number. Methods of handling bees are influenced by the prevalence of early-blooming plants and the nature of the early honey flow.

Localities may have peculiar local problems. For instance, in a locality already heavily stocked with bees, a general shift in type of farming from livestock systems to systems with more cash crops and a smaller acreage of legumes may force beekeepers to alter the established practice of handling bees or to accept smaller honey crops. General weather conditions, prevailing winds, and severity of winters may result in different practices for different localities. The nature of the honey flow may differ in various localities sufficiently to result in the use of different systems of handling bees or in modification of accepted systems.

APIARY ORGANIZATION

AS SHOWN BY INVENTORIES AND RECORDS

In harmony with the wide range in climatic conditions and the differences in individual beekeepers, a wide range in apiary practice and business organization is shown by the records obtained from the forty beekeepers at different points in the Intermountain Region. Closely associated with methods followed is the quality

Table 2.—Number of producers having apiaries of different sizes, average number of colonies, and production

Owners are producers of-	Number of colonies	Number of producers	Average number of colonies			Total average production per producer			Average production per colony	
			In spring	In summer	In fall	Cases of comb honey	60 lb. cans of extracted honey	Pounds of wax	Cases of comb	Pounds of extracted
Extracted honey	399 or less	10	253	274	285	2	445	451	-	93
	400 to 799	8	506	555	541		911	887	-	98
	800 to 1,199	5	903	998	991		1,595	1,324	-	93
	1,200 or more	4	1,443	1,615	1,693	175	2,130	2,201	-	83
Comb honey	399 or less	4	199	215	212	530	30	169	2.8	11
	400 to 799	6	526	650	663	1,396	370	400	2.8	36
	800 or more	2	1,080	1,225	1,245	7852	185	288	5.5	12

of the product obtained and the effectiveness with which labor is used. All of these have an influence on the expense of operation and on the resultant profit or loss

Size of Apiaries

Records of 27 producers of extracted honey, 12 of comb honey, and 1 of bulk comb and liquid honey were obtained. The number of colonies to a producer ranged from about 150 to 1,800, and, while honey was the chief source of personal income, some of the operators with a few colonies had other interests. In no case, however, could the apiary be considered a side line and, in this study, the beekeeping work of each individual is considered a complete business unit.

Table 2 shows that of the 39 beekeepers, not including the producer of bulk comb honey, 14 were handling less than 400 colonies, 14 were handling between 400 and 799 colonies, and 11 were handling 800 colonies or more. This grouping is probably representative of the range of size in apiaries in the Intermountain Region. The increase shown between spring and summer count of colonies just about equals the loss of the previous winter. Some operators increased the number of their colonies but, on the other hand, some were unable to maintain the spring count. Where colonies were doubled for wintering the count was adjusted to be comparable with those wintered singly.

Yields of Honey

The yield of extracted honey ranged from 30 to 200 pounds per colony. That of comb honey ranged from 1 to 7 cases per colony. The yield per colony was as good for large as it was for small operators. In general, an operator with more colonies than he himself could care for employed extra help, so that the large producers used as much labor per colony, in the yards, as did the small ones. There were some beekeepers, however, who cared for a large number of colonies with less than the average attention, and who hired extra labor only at the time of taking off honey. For these men the production per colony probably would have been greater had more care been given the bees at the proper time, yet the production per man and the net profits for the season might have been less. The operators in the group having an average of 274 colonies (summer count) obtained an average of 445 60-pound cans of honey, while those in the group averaging 555 colonies obtained an average of 911 cans. Those in the group averaging 998 colonies per operator averaged 1,595 cans of honey. Expenses were, of course, greater on the larger business units.

Labor Force Used on Apiaries

The larger earnings generally obtained from large apiaries is not a true measure of the merits of large units as compared with small ones. With only 250 colonies a man may have time to carry on outside enterprises. Figure 1 shows the seasonal use of labor on an apiary of 250 colonies of bees, and indicates that except for brief periods during the summer some other enterprise not exacting in its time demand for labor could have been carried. With an apiary of this size little work would be required during the winter. The line drawn at 48 hours per week shows that only during six weeks of the season from April 24 to November 10 was more labor required than eight hours per day for six days per week for the 250 colonies, while, during the other weeks shown, considerably less labor was used, giving an average of 4½ hours per day during the period from April to November.

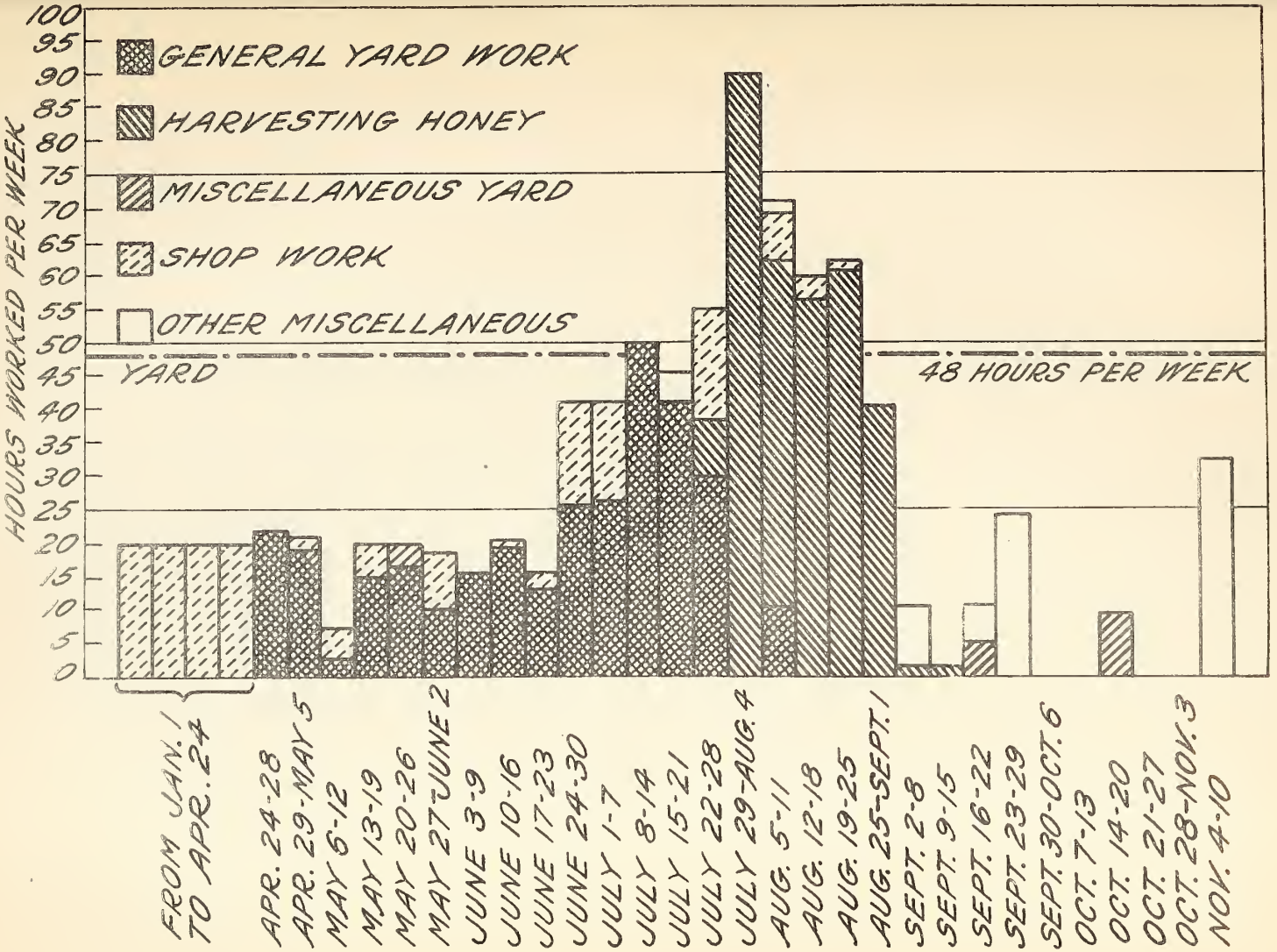


Fig. 1.--Seasonal use of labor on an apiary of 250 colonies

With 500 or 600 colonies the time of one man was used for most of the year, with additional labor throughout the summer. A few apiary systems of this size were cared for by one man; but unless conditions were exceptional additional labor was required. With an apiary of this size, one man will find considerable work to do during the winter in preparing for the next year's run. He will not be busy every day in the year, although at times he will be compelled to hire labor or put in extra time himself. In three of these moderate-sized apiaries, the work and income were as follows:

	Apiary 1	Apiary 2	Apiary 3
Number of colonies	450	472	536
Total 8-hour days worked	133	148	236
Hours of work per colony	2.36	2.51	3.52
Average yield per colony (pounds)	170	133	60
Cost of production per pound	$0.026	$0.031	$0.049
Net income from apiary	$4,295.	$2,831.	$1,083.

An apiary of 1,500 colonies employed a crew of four to six men during the busy season of the honey flow, and used the labor of two men throughout the entire year. Up to a certain number of colonies the increase would not require a proportionately greater use of labor. The larger apiaries ordinarily have better or more complete equipment, which may result in economies in labor and permit a more systematic planning of the work through division of labor. The larger unitds often tend to the less intensive methods of handling bees.

ORGANIZATION OF LARGE AND SMALL UNITS

The business of organization of a unit handling 200 colonies is, of course, simpler than if 1,200 or 1,500 colonies are handled as a unit. The larger unit requires hired labor, more equipment, and more widely scattered locations, and involves problems of transportation and management not met in the small organization. It may be added that the kind and distribution of honey plants will affect the organization of the business as well as limit its size.

With a few colonies of bees located near a small honey-house, little equipment for transportation is needed; the operator can do the work himself and perhaps dispose of his honey locally; with careful attention, good results may be obtained without a systematic plan for arranging out-aparies or adjusting the number of colonies, the hired labor, and the equipment, in order to form an economically operated unit. With a larger number of colonies and many out-aparies the gain through good systems of management is much more evident than with the smaller apiaries.

With one exception all producers from whom records were obtained managed one or more out-apiaries. On the average, the number of colonies per apiary was less than 100, though the range was from 30 to 250.

The number and location of the bee yards has a decided influence on the size of the business that can be handled by a given labor force. Obviously, the yards near the honey-house can be cared for with less labor than can the out-apiaries, and less time is lost in travel and in moving supplies.

For a beekeeper to increase the number of his colonies and apiaries would mean that he must accept less desirable locations than those already occupied (presuming that he has occupied the best locations available), or that the new apiaries will be located at greater distances from headquarters. The character of the range, including the abundance of honey plants and their distribution, may, therefore, be the limiting factor in the size of the business. Where the apiaries are far from the honey-house, portable extracting plants or temporary headquarters are often employed to reduce travel. Although the bee yards must be located with regard to the nectar-producing plants within the range of flight, a systematic arrangement of the out-apiaries may help to reduce the time and expense of travel.

Though the beekeeper operating on a small scale can do all or practically all of his own work, the man with more extensive operations must depend to some extent on hired labor. This, with the difficulty of obtaining short-time labor, may limit the extent of operations.

Lack of equipment, difficulty of increasing the number of colonies, or lack of finances for purchasing colonies or equipment may be obstacles to increasing the size of the business, even when range and labor are not limiting factors.

As a business increases in size a larger proportion of the operator's time must be spent in supervising the work and managing the business. Advantages of a larger business arise from a more complete use of equipment, and from the use of larger units or better equipment. With a large volume of business an operator can afford to build a more expensive honey-house, so arranged and equipped as to care for the crop with the least labor possible. He has also an advantage in purchasing supplies in large quantities or in having machinery with which to make some of his supplies.

On the other hand, the operator of a small business can give more personal attention to the bees and may take advantage of a local market to dispose of his crop at prices higher than those in the wholesale market. He has less cash outlay for hired labor and, while the chance of obtaining a large income is less than in operating large apiaries, the prospect of incurring a large loss is also less.

EXPENSES INCURRED IN HONEY PRODUCTION

On the small apiaries, as shown in Table 3, the chief items of expense were for supplies and honey containers. Such purchases as foundation, sections, shipping cases, and cans depend on the size of the crop, while expenses such as most of the labor in the yards, operation of truck, and yard rents are incurred regardless of the yield. The operator can do most of the necessary labor when the size of the apiary does not exceed 400 to 600 colonies. On the larger apiaries hired labor becomes a more important item, while the average expense per colony for truck and auto and miscellaneous expenses are also larger.

Table 3. Average cash outlay and hours of unpaid labor expended in honey production

Items of expense	By producers of extracted honey having-				By producers of comb honey having-			
	Less than 400 colonies	400-799 colonies	800-1199 colonies	1200 or more colonies	Less than 400 colonies	400-799 colonies	800-1199 colonies	1200 or more colonies
Truck and Auto	$89.00	$168.00	$340.00	$449.00	$44.00	$161.00	$414.00	$1,259.00
Hired labor	157.00	346.00	982.00	2,946.00	67.00	468.00	1,934.00	3,366.00
Supplies	52.00	109.00	136.00	331.00	183.00	134.00	809.00	1,387.00
Bees and queens	16.00	29.00	123.00	165.00	9.00	26.00	51.00	315.00
Repairs and equipment	68.00	51.00	239.00	522.00	25.00	26.00	41.00	45.00
Yard rent	16.00	45.00	86.00	191.00	21.00	55.00	10.00	75.00
Containers	203.00	366.00	849.00	1,241.00	125.00	153.00	774.00	2,449.00
Other items	74.00	115.00	455.00	486.00	38.00	133.00	380.00	1,421.00
Inventoried supplies (1)	94.00	258.00	536.00	181.00	163.00	804.00	638.00	1,581.00
Total cash expense	$769.00	$1,487.00	$3,746.00	$6,512.00	$675.00	$1,960.00	$5,051.00	$11,898.00
Cash outlay per colony	$2.81	$2.68	$3.79	$4.03	$3.14	$3.02	$5.94	$7.44
Hours of unpaid labor	859	1,189	1,409	1,309	1,094	1,300	1,359	2, 191

(1) Inventoried consumable supplies represent a cash outlay incurred before the records were begun.

For the large apiaries as well as for the small the supplies used are, of course, dependent on the size of the crop. Even with similar yields, "out of pocket" costs per colony are proportionately greater for the large business units than for the small.

The total cost of handling a colony of bees throughout the season ranged from $12.50 to $2.04 for different operators. At 50 cents per hour the highest labor cost was $4.47 per colony and the lowest $1.09, while charges other than labor ranged from $9.65 to $0.47 per colony. Future studies should reveal the reasons for such wide variations and indicate the significant factors responsible for low and high expense for labor and other items.

DISTRIBUTION OF INVESTMENT

The distribution of the investment on apiaries of different sizes is given in Table 4. The investment per colony averaged $18.68 for extracted honey and $20.30 for comb honey producers. The amount invested varies with the size of the business unit and the kind and condition of the equipment. On the average, the value of bees, including the hive body, bottom, and cover for each colony represented about 40 per cent, permanent bee equipment about 33 per cent, and buildings about 13 per cent of the total investment.

Although in establishing an apiary or a system of apiaries equipment is a major item of cost, its depreciation and the interest on the investment are, thereafter, comparatively small. The investment in bees, in supers and drawn combs, queen excluders, and the like, was roughly proportional to the number of colonies handled, but the investment in honey-houses and equipment such as extractors was not proportionately larger for a large number of colonies. Total investment per colony of bees tended to be somewhat smaller on large than on small apiaries.

While equipment in use, and its replacement, is not a heavy charge to the business, the purchase of equipment that is not needed or will soon be discarded is an important item. On most apiaries there were numerous small items of equipment which were seldom used. On some the investment in expensive extractors or other large units of costly equipment was not justified by the number of colonies of bees handled nor by the production obtained. On the other hand, some operators had too little equipment for the work to be done or had equipment too poor to secure best results.

In a few instances the investment in unused equipment was large because the extent of operations had been much reduced in recent years, or because the operator had changed or was changing his line of work, as from comb honey to extracted honey production.

Table 4.--Average investment per business unit for apiaries of different sizes

Size of apiary	Bees (1)	Buildings	Truck and auto	Permanent bee equipment	Supplies and product	Total per operator	Average per colony
			Producers of extracted honey				
	$	$	$	$	$	$	$
Less than 400 colonies	2,402	780	370	2,617	257	6,426	23.45
400 to 799 colonies	4,291	1,293	643	4,170	638	11,035	19.88
800 to 1199 colonies	7,832	2,209	889	7,230	845	19,005	19.24
1200 or more colonies	11,987	3,529	1,337	7,544	733	25,130	15.56
Average	5,389	1,604	690	4,662	549	12,892	18.68
			Producers of comb honey				
	$	$	$	$	$	$	$
Less than 400 colonies	1,552	1,111	704	1,660	311	5,338	24.83
400 to 799 colonies	5,019	1,629	641	4,733	1,034	13,056	20.09
800 to 1199 colonies	6,000	4,000	720	3,933	807	15,460	18.19
1200 or more colonies	16,000	2,750	2,200	8,420	1,879	31,249	19.53
Average	4,860	1,748	798	3,949	845	12,200	20.30

LABOR AND RETURNS ON EXTRACTED HONEY

Most beekeepers in the Intermountain States produce extracted honey and sell the product wholesale in cases of two 60-pound cans, though some is sold in 2½-, 5-, or 10-pound pails, some being sold locally.

The number of colonies handled during the season by the 27 producers of extracted honey averaged 690, and ranged from the smallest unit, 161 colonies, to the largest, 1,800. Of ten of the producers each had less than 400 colonies. These smaller apiaries were often handled in connection with other business, the operator working part time in the apiary and hiring some labor. Some of these operators, however, were doing practically all of their own apiary work and devoting most of their time to honey production. Eight producers, handling between 400 and 800 colonies each, spent most of their own time in the apiaries and, as a rule, hired extra labor during the season. On larger apiaries most of the labor was hired.

Earnings of Management

Earnings of management, shown in Table 5, assuming a flat rate of 50 cents per hour for the operator's labor and an interest charge of 6 per cent on the investment, averaged $615.90 for producers of extracted honey. The highest return for management to a producer of extracted honey was $5,714. In one case the gross in-

(1) The value of bees reported includes one hive-body, bottom, and cover, for each colony.

Table 5.—Average returns to honey producers, Intermountain section, 1928

Number of colonies	Number of producers	Number of colonies of bees per operator	Honey per colony	Net value of production (1)	Earnings of management (2)	Estimated cost of honey (3)
			Producers of extracted honey			
			Pounds			Per pound
Less than 400	10	274	93	$924.23	$249.78	$ .07
400 to 799	8	555	98	1,941.53	832.56	.074
800 to 1199	5	998	93	2,043.37	201.36	.072
Over 1200	4	1,615	83	3,692.01	1,616.03	.054
All apiaries	27	690	93	1,842.94	615.90	.069
			Producers of comb honey			
			Cases			Per Case
Less than 400	4	215	2.8	$ 1,252.82	$ 470.40	$ 3.66
400 to 799	6	650	2.8	4,658.32	3,277.62	1.94
Over 800	2	1,225	5.5	16,376.58	14,179.04	1.58
All apiaries	12	601	3.5	5,476.19	4,158.79	2.45

(1) To the difference between cash receipts and cash expense the value of the net change in inventory has been added, and the value of unpaid labor subtracted.
(2) Earnings of management represent the income remaining to the operator after allowing a deduction of 50 cents per hour for unpaid labor and 6 per cent interest on the investment.
(3) In estimating the cost of honey a figure for net charge was divided by the total honey production. The net charge includes the sum of the cash expenses, all unpaid labor at 50 cents an hour, interest at 6 per cent on total investment, less a sum representing sales of wax and changes in inventories.

come was insufficient by $3,238 to pay all charges and to allow 50 cents per hour for the labor of the operator and 6 per cent interest on the investment.

For all producers of extracted honey the difference between the total value of production and the expenses averaged $1,842.94 per operator, whereas the earnings of management alone averaged $615.90. This value of the product is based on a value for honey at 6¾ cents per pound and for wax at 27 cents per pound. To be sure, many producers obtained better prices than this, but as much of the crop was sold at approximately these prices they were used in estimating returns. Most of the cash expenses were for containers, labor, expense of truck and auto, and purchased supplies. Allowance was made for unpaid labor other than that of the operator, and the difference between value and expenses was corrected for changed inventory values. To obtain earnings of management a charge for the operator's labor at 50 cents an hour and interest at 6 per cent on the investment was deducted from the net value of the product.

Although efforts to reduce the cost of producing honey should lead to greater profits, the lowest possible cost per pound does not necessarily result in greatest profit for the operator. Profits are also linked with the size of the business or the total production of honey. Assuming that the producer on a large scale sells his honey for the same price per pound as does the producer of a small amount, the former could permit higher costs and still have a larger personal income. For example, an efficient producer having costs totaling 3 cents per pound for 30,000 pounds of honey which sell at 7 cents per pound would have a return of $1,200 net, whereas a producer of 120,000 pounds having a cost of five cents per pound at the same price would have $2,400 as the net return. Personal incomes may sometimes be increased through larger operations even though the same degree of care can not be given to the larger business. On the other hand, there seem to be situations where it would be well for the producer on a small scale to keep his costs low and devote his spare time to some other industry which might yield him a good profit in years when the honey flow gave him little or no income.

Table 6 shows roughly the effect which yield per colony and the number of colonies had on earnings of 27 extracted honey producers. The larger earnings were from large apiaries with good yields or from medium sized apiaries with high yields. The heaviest losses were on large apiaries with low yields. The small apiaries even with good yields could not return large earnings to the operator. Most of the losses are small and occur on apiaries with low yields of honey per colony.

The largest loss shown was due to a low yield of honey combined with the loss of a large amount of equipment because of American foulbrood. Another large loss occurring in a small apiary was due to a low yield of honey and heavy loss of adult bees from disease. In another instance the high value set on the increased number of colonies results in a large gain being shown in an apiary having a comparatively low yield of honey. Where yields of 90 pounds or more per colony were obtained the returns were generally favorable, while for yields of less than 60 pounds the returns were more likely to be unfavorable than otherwise. The only considerable profit in spite of low yield of honey was shown by one operator who largely increased the number of his colonies.

Table 6.--Earnings of management compared with number of colonies and yield per colony for 27 producers of extracted honey

Earnings of management	Number of colonies	Honey per colony
		Pounds
$ 5,714	1,709	118
4,290	1,350	61
3,971	745	190
3,341	450	170
2,180	472	133
1,662	340	161
1,600	300	159
1,368	932	128
1,175	1,200	145
930	900	71
900	700	93
376	250	51
304	300	109
281	205	99
179	161	45
26	536	60
20	370	91
-166	438	33
-317	265	101
-353	400	74
-544	300	82
-1,063	250	36
-1,192	1,060	90
-1,273	900	33
-1,589	1,800	83
-1,951	1,600	69
-3,238	700	30
616	690	93

Similar conclusions may be drawn from Table 5 on the estimated cost per case of comb honey or per pound of extracted honey. The estimated cost was obtained by dividing the total net charge by the total production. The net charge was obtained by deducting the credits for wax, comb honey (when the cost per pound of extracted honey was being figured), bees and supplies sold, and increase in inventories, from the total charge, which includes decrease in inventories, cash expenses, operator's labor, and interest on the investment.

These costs for extracted honey averaged 7 cents per pound for all apiaries with less than 400 colonies, 7.4 cents for all apiaries having 400 to 800 colonies, 7.2 cents for apiaries between 800 and 1,200 colonies, and 5.4 cents for apiaries with more than 1,200 colonies. For individuals the cost per pound ranged from 2 to 22 cents. No attempt was made to separate the cost of increasing the number of colonies from that of producing honey. Changes in inventory resulting from increase or loss

of bees have an important effect on the cost of honey as the cost was computed in this investigation. This point is particularly important where increase of bees was made and the charges for labor and material were less than the assumed value of the bees.

Figure 2 shows the range from very high to very low cost per pound of honey corresponding to the yields obtained per colony. Good yields are most often accompanied by low costs, whereas low yields are most often accompanied by high costs per pound. Factors other than yield are, of course, to be considered. As computed the cost figure is very sensitive to changes in the inventory. The costs shown by the solid line of the chart are accordingly modified by making a correction for increased or decreased values in the inventory due to increases or losses of colonies of bees, exclusive of hive bodies and frames. With this correction many of the high costs are lowered, whereas some of the extremely low costs are increased. The effect of this correction is shown by the crosses which accompany the solid line. For instance, one apparently low cost of about 1.5 cents per pound is increased to 5.5 cents by adding to the net charge $2,909 previously deducted as increased value of bees. One high cost of 18.7 cents is decreased to 11.5 cents by subtracting from the net charge $637.50, the decrease in value of bees which had been included as a charge made against total production.

Other factors affecting the cost per pound are the quantities of foundation, frames, and similar supplies used, the amount of labor used in handling bees, and the cost of operating trucks, autos, and equipment. Some producers with low yields of honey have unusually low costs because of economical use of labor, supplies or equipment. Others with good yields have high costs.

It should be observed, also, that low yields, though usually due to seasonal conditions over which the operator has no control, were sometimes due to faults in management, often including poor wintering. In some cases poor wintering appeared to be due to poor preparation for winter, including quality of bees and quantity and quality of stores, resulting in great loss of bees after flying began in the spring. Apiaries were visited in which, owing to these causes, egg laying had ceased, brood was being dragged from the hives, and some colonies had died. Many other causes tend to lessen the yields of honey.

When a charge of interest on investment or a charge for depreciation of equipment is included, this may be heavy for operators who carry much more than their needed equipment or who do not use the equipment fully. For instance, operators with double the equipment or investment in honey-house needed to care for their honey will have computed costs somewhat higher than those with a nice balance between equipment and number of colonies.

Labor

Table 7 shows the average number of hours worked on apiaries grouped by sizes and the corresponding average time required per colony.

While some men put as much as 8 hours of time on each colony, others used only 2 to 3 hours per colony. Much of the labor was used regardless of the yield obtained, although a very heavy yield required some extra labor. The methods of management, the ability of the worker, the distances to be traveled, and the equipment used are factors affecting the amount of labor required. On the average, in the production of extracted honey, about 3¼ hours of work and about one-half an hour of travel were used per colony. Although the producers of extracted honey used less

labor per colony of bees than did the producers of comb honey, the reasons for variations in the amount of labor are generally the same as those discussed under labor on comb honey.

LABOR AND RETURNS ON COMB HONEY

The yield of comb ranged from 1 to 7 cases per colony, with an average of 3.4 cases. The good yields were obtained by a few men with large apiaries, so not many operators really received as much as the average. Only four producers averaged three cases or more per colony. Of course returns are very much affected by the yield obtained.

The return to the operator for his own labor and his investment is closely tied up with the yield per colony; and, with the exception of a few producers who had unusually large yields, this return was very much the same as for the producers of extracted honey.

Because of the wide range in yields and size of business there was a great difference between the high and the low earnings for producers of comb honey. With the small number of reports the averages can not be taken as representative of returns for producers in this region. As shown in Table 5, the earnings of management averaged $4,158.79 for all reports, with an average of $470.40 for the group of smallest units and $14,179.04 for the producers with a large number of colonies. The large returns for the latter group were due to very high yields, as well as to the number of colonies handled. This sum for earnings of management, representing the net return to the operator, after allowing all charges, 6 per cent on the investment, and 50 cents per hour for his own labor, ranged from over $20,000 on the most profitable unit down to a loss of nearly $1,200. On the apiary with lowest returns, low yields, coupled with loss of bees, resulted in the lack of earnings for the operator.

Returns for labor and management for each hour worked by the operator, after allowing 6 per cent charge on the investment, ranged from $11.78 down to a loss of $1.61.

The estimated cost per case of comb honey ranged from near $1.00, in a few instances, to as high as $8.00. For most producers the computed cost was not far from $2.50 per case. Because many of the producers of comb honey were located in sections where good yields were obtained in 1928 the average yield of comb honey and average return to operators were relatively greater than these averages for producers of extracted honey. The cost of comb honey as compared with that of extracted honey, as shown in Table 5, would then be relatively lower than normal unless, as may be the case, the production of comb honey is and can be carried on successfully only in certain sections having the character of honey flow and other requirements necessary to insure a large crop of comb honey of fine quality. Producers have found some of the essentials for the production of fine comb honey to be a rapid flow of honey of the quality wanted combined with freedom from propolis and from honey of undesirable quality. Such locations are few and are, in general, quite regularly productive of good crops of honey. Satisfactory locations for producing comb honey are becoming fewer because the market demands an increasingly higher quality of it.

The labor records of producers of comb honey indicate that 36 per cent of the labor used in handling bees for comb honey was used in taking off and cleaning the honey. One-fourth of the labor, that of cleaning honey, depended entirely on the size

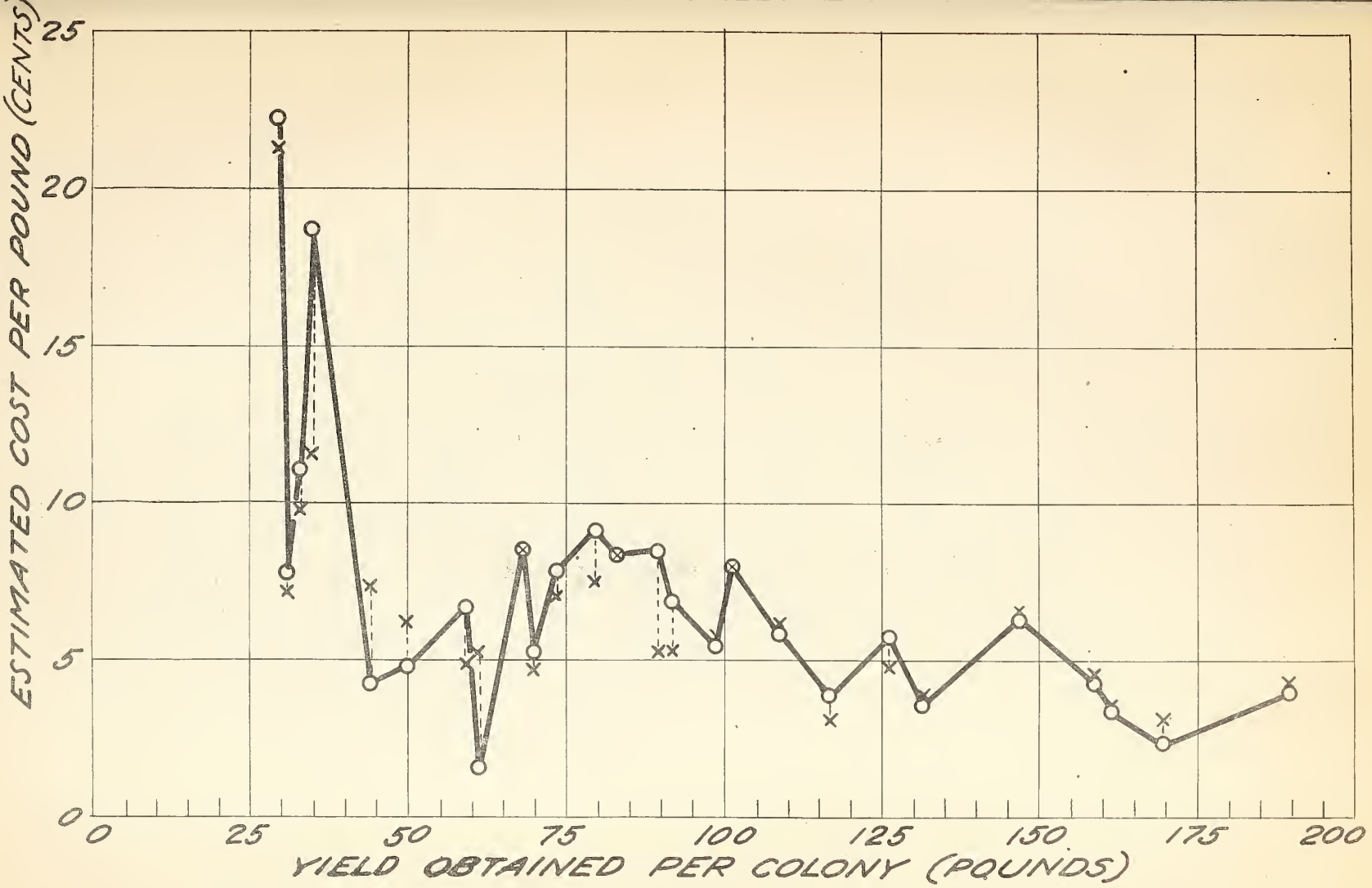


Fig. 2--Cost per pound of extracted honey as related to yield per colony. The points in the solid line show for various producers the apparent cost per pound of producing extracted honey, while the crosses show the actual cost after allowance has been made for increase or decrease in inventories

Table 7.—Labor used in producing honey in apiaries classified according to number of colonies

Number of colonies	Number of producers	Average number of colonies	Total time			Time per colony		
			Number of hours of work	Number of hours of travel	Total number hours	Number of hours of work	Number of hours of travel	Total number hours
Producers of extracted honey								
Less than 400	11*	265	1,161	116	1,277	4.4	0.4	4.8
400 to 799	8	555	1,941	158	2,099	3.5	.3	3.8
800 to 1199	6*	1,011	3,261	486	3,747	3.2	.5	3.7
over 1200	4	1,615	4,893	667	5,560	3.0	.4	3.4
Average		685	2,250	269	2,519	3.3	.4	3.7
Producers of comb honey								
Less than 400	4	215	1,148	67	1,215	5.3	0.3	5.6
400 to 799	6	650	2,193	284	2,477	3.4	.4	3.8
over 800	3*	1,100	7,083	410	7,493	6.4	.4	6.8
Average		620	3,000	246	3,246	4.8	.4	5.2

* Includes one labor record from an apiary not included in previous tables.

of the crop, as did much of the time spent in preparing supplies and in general shop work.

The work of caring for the bees, or about one-third of the total, depended more on the number of the colonies than on the size of the crop. In general, this fact will explain a part of the variations in labor reported. Operators with the highest production generally used the most labor per colony, although there were exceptions, and it is from the methods used in exceptional cases that most can be learned. It is hardly safe, however, with the incomplete records and observations of but one season, to make definite statements, as it was often impossible to determine what percentage of favorable result was due to management or what to seasonal variation. It therefore seems better, in most cases, to give the figures and results as food for thought than to attempt to recommend specific practices, even though some practices do indicate results far above the general level.

On the average $5\frac{1}{4}$ hours were spent per colony by producers of comb honey. Four and three-fourths hours were spent in actual work, including yard work, shop work, and the work of taking off honey and preparing it for market. One-half hour was used for travel.

The time required for travel depended largely on distances and on the condition of the roads, although arrangement of apiaries and facilities for travel were conditioning factors. For instance, one operator with apiaries at an average distance of $17\frac{1}{4}$ miles reported $1\frac{1}{3}$ hours of travel per colony, while another with practically the same number of bees and more apiaries traveled only one-half an hour per colony. The second operator had the apiaries in two groups, and worked a number of apiaries from a temporary station. Since each did practically the same amount of work per apiary, the extra time of travel would seem to be due to arrangement of apiaries or to organization of the work. Over one-half of the time of travel was used at the time of the spring work in the yard and 30 per cent of it for taking off and hauling honey.

In general, the hours of shop work were consistent with the yield obtained. The men who obtained largest yields generally used most labor per colony.

A G R I C U L T U R A L E X P E R I M E N T S T A T I O N

Oregon State Agricultural College
Corvallis, Oregon

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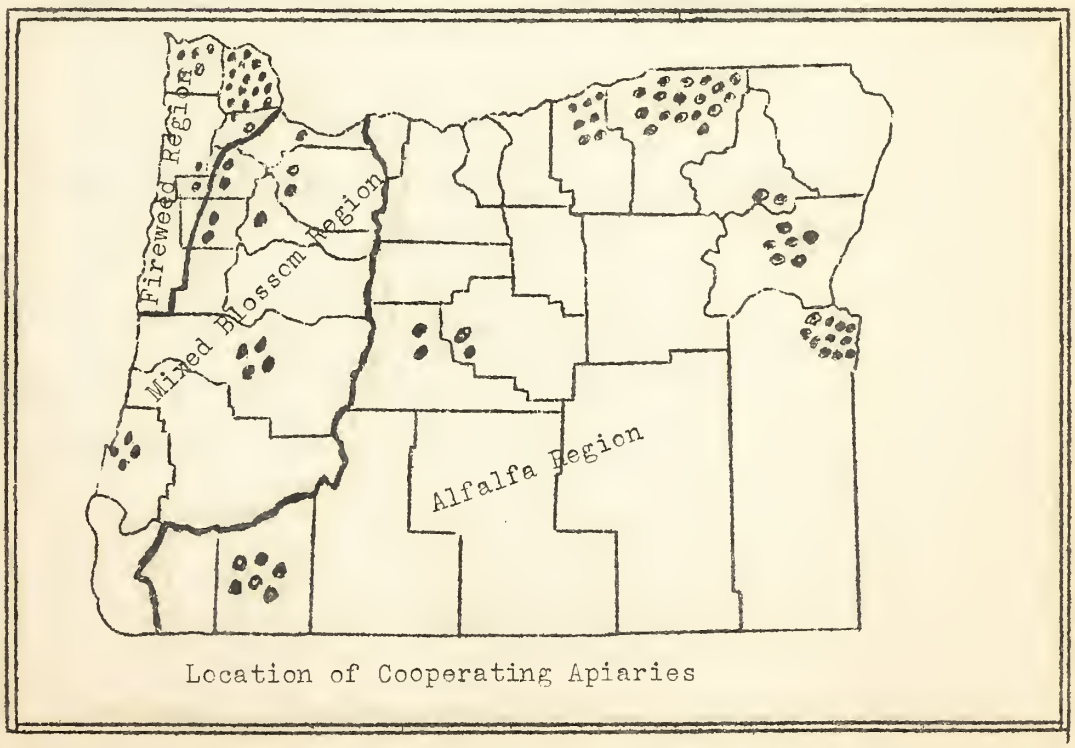
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Location of Cooperating Apiaries

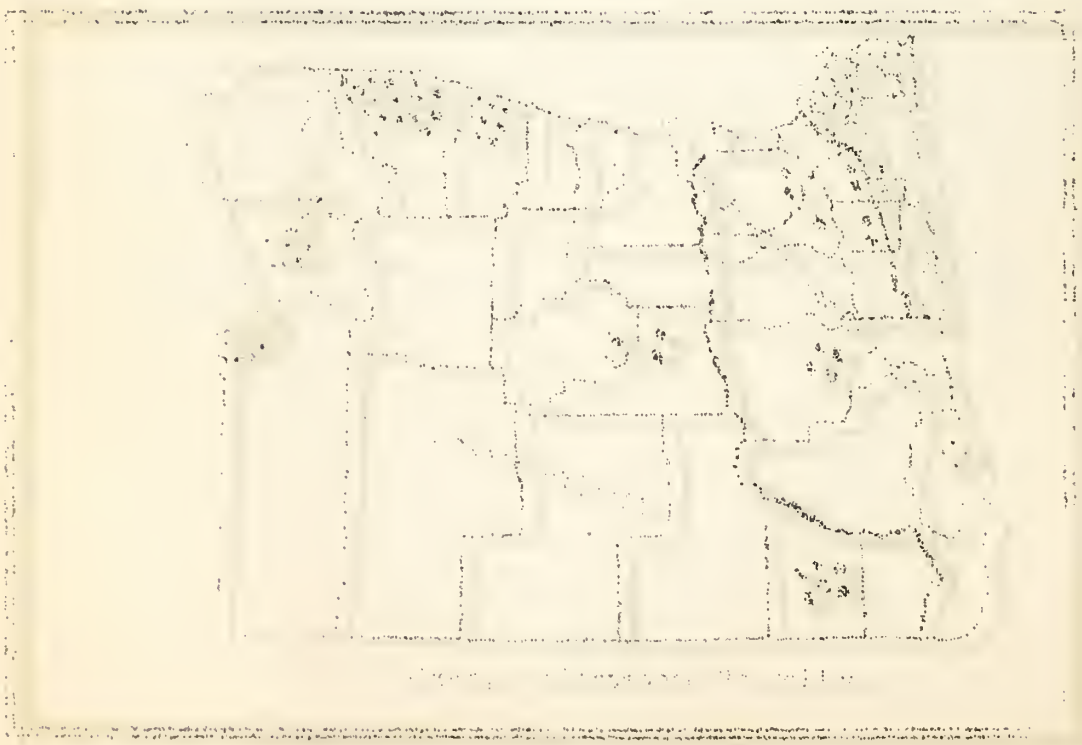


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THE SITUATION

Over the four years 1928-1931 there was an average of 4,700,000 colonies of bees in the United States with an average annual production of 94,000 tons of honey, according to unofficial estimates published by the Honey Market News Service of the United States Bureau of Agricultural Economics. Although beekeeping is practiced in every state, there are few localities where it may be said to be concentrated. The leading states in honey production are California, Iowa, Wisconsin, Michigan, Illinois, New York, and Texas. No state produces more than approximately 8% of the Nation's total.

The bulk of the honey produced in the United States is also consumed here. There is some in-shipment of honey, chiefly from Hawaii and Porto Rico, and some out-shipment, principally to Germany and the United Kingdom. The average yearly net exports from 1928 to 1931 were 2,106 tons, or 2.2% of the estimated United States crop.

Oregon is not a leading honey-producing state, but does have a substantial honey industry. It is estimated that in the four years under discussion there were 64,375 colonies in the state, which averaged yearly 1,200 tons of honey, valued at $200,000. This production amounts to 1.3% of the total United States crop. There are 28 states producing more and 19 states producing less honey than Oregon.

At present the bulk of the Oregon-produced honey is consumed within the state. Market outlets are chiefly by private sale from producer to jobber, grocer, or consumer. Until recently most beekeepers were able to find a ready market for their honey at a price satisfactory to all concerned. At present, however, a different situation prevails. Owing to the depressed conditions generally, honey is finding slow sale at prices satisfactory to the producer. Honey is being shipped in from outside points to compete with home-produced honey, and much complaint about price cutting is heard from producers. Furthermore, even among themselves, local beekeepers seem to find it necessary continually to underbid each other in order to move their honey. This condition of keen competition is now spreading throughout the honey markets of the state, where formerly little real competition was manifest.

The keen competition for markets and the resultant low prices bring this question to the mind of many beekeepers--"Are we keeping bees for pleasure and profit or only for pleasure?" Most beekeepers can not afford to operate bee yards for pleasure only, but must maintain their profits or else discontinue business. Apparently the only way in which to do this is to reduce production costs. It is believed that the future of the apiaries operated by many of our Oregon beekeepers is directly dependent on the cost at which these beekeepers can produce honey.

Little information on honey-production costs has heretofore been available. At the request of the Oregon State Beekeepers' Association, the Oregon Agricultural Experiment Station and the Pacific Coast Bee Culture Field Laboratory, located at Davis, California, have commenced a cooperative study of this phase of honey production.

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PURPOSE OF THE STUDY

The objectives of this study are:

1. To determine the cost of producing honey in Oregon.
2. To determine the major and minor factors responsible for variations in the cost of producing honey.
3. To determine and recommend adjustments that will reduce the cost of producing honey.

METHOD AND SCOPE OF THE STUDY

This study, which is to cover two seasons' production, is being conducted by the survey method. The report deals with some of the chief points of interest developed from the first year's work on this project. All material presented in this report is preliminary in character and is subject to revision.

Cooperators for this study were selected almost entirely from apiarists operating 50 or more colonies of bees, for the primary purpose was to supply facts concerning commercial honey production rather than production largely for home consumption and local sale.

A total of 93 apiarists operating 17,803 colonies of bees, cooperated in this study during 1931, which probably represents 45% of all the colonies in Oregon. Each cooperator gave a record of production costs and management practices for his bee enterprise for the year 1931. Of these cooperators 85 were engaged chiefly in extracted-honey production and 8 were primarily comb-honey producers. About 40% of the extracted-honey producers also produced small quantities of comb or chunk honey, while the other 60% extracted their entire honey crop. All but one of the 8 comb-honey producers also produced some extracted honey.

Oregon has three distinct sets of important honey flora; namely, the clover-alfalfa flora of eastern Oregon and the Rogue River Valley of southern Oregon, the fireweed of northwestern Oregon, and the clover-vetch-mixed blossom flora of the Willamette and Umpqua Valleys and areas in southern Oregon lying outside the Rogue River Valley. These regions, as well as the number and distribution of records in each, are indicated on the map shown on the cover page of this report, and hereafter will be referred to as the alfalfa, fireweed, and mixed-blossom regions.

The regional distribution of cooperating beekeepers, the total number of colonies included in their apiaries, and the total quantities of honey produced by these colonies are shown in Table 1.

Table 1. REGIONAL DISTRIBUTION OF HONEY-COST RECORDS, 1931 CROP

Region	Cooperators		Colonies of bees		Total honey produced*		Average no. of colonies per beekeeper	Yield of extracted honey per colony (pounds)**
	Number	% of total	Number	% of total	Pounds	% of total		
Alfalfa-clover	53	57	13,179	74	838,971	76	249	68
Fireweed	17	18	3,373	19	209,563	19	198	63
Clover-vetch-mixed blossom	23	25	1,251	7	50,873	5	54	44
Total or average	93	100	17,803	100	1,099,407	100	191	65

See footnotes next page.

* Includes both extracted and comb honey produced by all 93 apiaries.

**Includes only the 85 apiaries producing extracted honey as a major product. These yields were obtained by dividing the equivalent in extracted honey of the total quantity of comb and extracted honey produced, by the total number of colonies in these apiaries. See Table 3.

THE BEE-ENTERPRISE INVESTMENT

For apiaries producing extracted honey, the capital invested in the bee enterprise averaged $2,014 per operator and $10.47 per colony (Table 2). For comb-honey production this investment was only $8.01 per colony. The difference was due chiefly to the smaller investment for hives and parts, combs, and harvesting equipment for the comb-honey apiaries. As only eight comb-honey apiaries are included in this study, the average for this group is not so conclusive as is the average for the extracted-honey group.

Table 2. CAPITAL INVESTED IN THE BEE ENTERPRISE, 1931*

Investment item	Apiaries producing extracted honey			Apiaries producing comb honey. Average per colony
	Average per operator	Average per colony	Per cent of total	
Bees	$531	$2.76	26.4%	$2.68
Hives and parts	670	3.48	33.2	2.52
Combs	474	2.47	23.6	.83
Miscellaneous equipment and supplies	112	.58	5.5	.48
Harvest equipment	102	.53	5.1	.16
Buildings	114	.59	5.6	.82
Apiary sites	11	.06	.6	.52
TOTAL INVESTMENT	$2,014	$10.47	100.0	$8.01

* The values shown in this table, with the exception of bees and apiary sites, represent the present depreciated values of these items.

The major portion of the bee-enterprise investment is devoted to providing the bees and giving them a place to rear brood and store honey. Of the total investment of $10.47 per colony, 26.4% is for the investment in the bees. Another 33.2% is for the investment in hives and parts, which includes top and bottom boards, all hive bodies, and frames. The combs (exclusive of the frames which contain them) account for 23.6% of the total investment. The sum of these three items makes up 83.2% or slightly over four-fifths of the total bee-enterprise investment.

Trucks and autos used in the bee enterprise have not been included in the capital investment in this study, but have been charged to the bees in the operating expense. If these two items were included in the bee-equipment investment, as they might properly be under some conditions, the average investment would be increased slightly.

The values shown in Table 2, with the exception of bees and apiary sites, represent the present depreciated value of these items, rather than the value of this equipment if purchased now.

The comb investment per colony represents an average of 31 drawn combs and includes those in the brood nest as well as other drawn combs that may be on hand. When first drawn, these combs were valued at 16¢ each for deep super combs and at 13-1/3¢ each for shallow extracting combs. Because of the greater age, the present depreciated value is 7.7¢ for deep super combs as compared to 8¢ for shallow extracting combs. The average age of the deep super combs is 4.3 years and the average age of the shallow super combs is 3.9 years.

Hive bodies are the chief item of the hives-and-parts investment. If two shallow extracting supers are considered as equal to one deep super, there was the equivalent of 3.2 deep supers per colony in addition to one hive body allowed for the brood nest. When purchased new by the beekeepers, the deep supers cost on the average 46½¢ and shallow supers 31¢. The present depreciated value averaged 27½¢ for deep supers and 20¢ for shallow supers, indicating that from 35 to 40% of the useful life of these supers is already past.

REGIONAL INVESTMENT

The investment per colony by regions is as follows:

Alfalfa region	$ 9.55
Mixed-blossom region	11.20
Fireweed region	13.48

The low investment in the alfalfa region is due chiefly to the fact that the average number of colonies handled per operator was greater than in either the mixed-blossom region or the fireweed region. These larger units permitted a lower investment per colony because (1) some items of equipment such as honey houses, extractors, steam boilers, motors, and so forth, cost about the same whether 100 or 200 colonies were handled; and (2) by buying such equipment as top and bottom boards, hive bodies, frames, and so forth, in good-sized lots the beekeepers were able to buy at somewhat lower prices.

The higher investment in the fireweed region as compared with that in the mixed-blossom region appears to be due chiefly to the facts that (1) more equipment is used per colony and (2) the beekeepers place a higher estimate on the value of drawn combs. Because the fireweed flow is frequently short, but heavy, it is probable that more supers and combs are needed than in the mixed-blossom region. Combs are valued more highly in the fireweed region because minor flows prior to the main flow are not heavy enough to cause much comb building, while the main flow is so short that any delay for comb building may cause a heavy loss of surplus honey.

THE COST OF PRODUCING EXTRACTED HONEY

The net cost of producing extracted honey averaged $3.89 per colony and 6.4¢ per pound of honey. (Table 3) The gross cost averaged $4.71 per colony and 7.8¢ per pound of honey, but in addition to the honey, certain by-products (Table 4) were also produced, and the value of these must be credited before the net cost of the honey can be ascertained. Both the gross and net costs, as presented, are for honey extracted, canned in 60-pound cans, and cased in 2-can cases. Of the total gross production cost, 36.3% is for labor, 11.5% is for materials and supplies, 20.0% is for miscellaneous items, 21.2% is for depreciation, and 11.0% is for interest.

Each apiarist operated an average of 192 colonies and each colony produced at the average rate of 65 pounds of surplus extracted honey in addition to the regular winter stores. In computing this yield, each pound of comb or chunk honey

was counted as the equivalent of 2 pounds of extracted honey, but in computing the cost per pound only honey actually extracted was considered, as the value of the comb and chunk honey produced is included in the by-product credits.

Table 3. COST OF PRODUCING EXTRACTED HONEY, 1931 CROP

Averages for 85 apiarists, operating 16,348 colonies and producing 995,797 pounds of extracted honey. Average number of colonies per operator, 192. Average rate of production per colony, 65 pounds.*

Cost item	Average cost per colony	Average cost per pound**	Percentage of total cost
Labor:			
Hired and contract	$ 0.22	0.3¢	4.7%
Operator and family	1.49	2.5	31.6
TOTAL	1.71	2.8	36.3
Materials and supplies:			
60-pound cans and cases	.37	.5	7.9
Bee feed (honey and sugar)	.04	.1	.9
Section boxes and foundation	.04	.1	.8
Power and fuel	.04	.1	.8
Other material and supplies	.05	.1	1.1
TOTAL	.54	.9	11.5
Miscellaneous:			
Use of auto or truck	.52	.9	11.1
Taxes	.09	.2	1.9
Apiary rent	.10	.2	2.1
Bees and queens purchased	.14	.2	3.0
Rent of bees	.07	.1	1.5
Other miscellaneous expense	.02	--	.4
TOTAL	.94	1.6	20.0
Depreciation:			
Hives and parts	.34	.5	7.2
Combs	.53	.8	11.3
Miscellaneous equipment	.04	.1	.8
Harvest equipment and supplies	.05	.1	1.1
Buildings	.04	.1	.8
TOTAL	1.00	1.6	21.2
TOTAL OPERATING COST	4.19	6.9	89.0
Interest (at 5%)			
Bees	.14	.2	3.0
Hives and parts	.17	.3	3.6
Combs	.12	.2	2.5
Miscellaneous equipment, supplies, harvest equipment, buildings, and apiary sites	.09	.2	1.9
TOTAL	.52	.9	11.0
TOTAL GROSS COST	4.71	7.8	100.0
Credit for by-products	.82	1.4	17.4
TOTAL NET COST	$3.89	6.4¢	82.6%

* In addition to the extracted honey, small quantaties of comb and chunk honey were also produced, making a total production equivalent to 1,065,447 pounds of extracted honey, where each pound of comb or chunk honey is counted as the equivalent of two pounds of extracted honey.

** The average cost per pound was computed by dividing the cost per colony by the quantity of honey that was actually extracted, which averaged 61 pounds per colony. Comb and chunk honey was credited to the gross cost as a by-product.

LABOR

The cost of labor was slightly more than one-third of the total gross cost. An average of 4.8 hours per colony was required for the entire year's work incident to honey production. Practically all of the labor is performed by the operator or members of his family, as but few operate on a scale sufficiently large to require additional hired help. When labor is hired, it is usually for extracting or for shop work such as repairing equipment and putting in foundation. Competent labor to assist with or carry on manipulation of the bees is difficult to procure in most places. The average wage paid hired labor was 27.8¢ per hour, and the labor of the operator and his family was valued at 36.8¢ per hour.

MATERIALS AND SUPPLIES

The chief cost for supplies was for cans and cases. Most of the cans were purchased new, as good second-hand cans suitable for marketing honey were hard to obtain in most sections. Cases were usually purchased from local lumber mills.

Feeding was practiced in one-third of these apiaries. Half of the beekeepers who practiced feeding used honey and the other half used sugar sirup.

Expense for section boxes and foundation occurred only where comb honey was produced as a side line. Although many beekeepers consider brood-comb foundation an operating expense, it is properly a capital investment since it is drawn out into comb and used for several seasons. In this cost summary, expense for brood-comb foundation is included in the charge for comb depreciation.

Electricity for lights and motors, kerosene and gasoline for stoves, lights, and engines, and wood or coal for steam boilers and heating stoves are included in the charge for power and fuel.

Paint, nails, lumber, lye, cellophane, and so forth, constitute the other materials and supplies.

MISCELLANEOUS COSTS

The charge for auto and truck use was 11.1% of the gross cost of honey production, or almost 1 cent per pound of honey. Of the apiarists cooperating, 85% used either trucks or cars and trailers in carrying on their honey enterprise. About half used trucks and half cars and trailers. Extensive beekeeping requires the use of out-yards to keep the bee population and the nectar supply in balance, and whenever out-yards are used transportation of men and equipment is a considerable item. On the average there were 4.3 yards per operator, averaging 44 colonies per yard, but ranging in size from 8 to 270 colonies. By using a smaller number of well-selected locations carrying a fairly large number of colonies, some beekeepers may be able to reduce this item of truck and car cost.

Taxes covered the taxes paid not only on the bee colonies themselves but also on buildings used for the bees and on any apiary sites that are owned.

About one-fourth of the operators purchased package bees, swarms, or colonies to make up losses and provide increase. Queens were purchased by 21% of the beekeepers.

Of the locations used by these operators, 59% were rented. The rent for three-fourths of these locations was paid in honey, the average rent being 85 pounds

of honey per yard. Bees rented or operated on a share basis were usually operated on 50-50 basis.

DEPRECIATION

Over a period of years bee equipment wears out and must be replaced. A portion of this wear should be charged to the bees each year. In this study the cost for this item was slightly over one-fifth of the total gross cost. All depreciation was computed according to the beekeeper's estimate as to the average life of each pieceof equipment. The largest item of depreciation was for combs (without frames) and the second largest was for hives and parts (top and bottom boards, hive bodies, and frames). The estimated rate of depreciation on combs was 10.8%. According to the pounds of brood-comb foundation actually used, there was a replacement of approximately 11.6% if the brood-comb foundation averaged 8 sheets to the pound, or a replacement of 10.8% if this foundation averaged only 7-1/2 sheets to the pound.

OPERATING COST

The sum of all items of cost except interest has been designated as operating cost. Cost can therefore be readily computed with or without the charge for interest.

INTEREST

Interest at 5% on the bee-enterprise investment amounts to 11% of the gross production cost. This rate of return represents what the bee-enterprise capital could normally be expected to earn if invested in sound investments.

BY-PRODUCT CREDITS

In addition to the honey produced, these apiarists also received other income from the bees to the amount of 82¢ per colony (Table 4). This income has been deducted from the gross cost in order to obtain the net cost of honey.

Table 4. VALUE OF BY-PRODUCTS OF EXTRACTED HONEY, 1931 CROP

Item	Average per colony	Average per pound of honey	Percentage of total
Pollination	$0.15	.3¢	18.3%
Wax	.17	.3	20.7
Bee appreciation	.15	.3	18.3
Comb and chunk honey	.33	.5	40.3
Queens and package bees	.02	--	2.4
TOTAL	$ .82	1.4¢	100.0%

About 14% of the apiarists rented out their bees for pollinating purposes on fruit or alsike clover. This practice is most prevalent in the mixed-blossom and fireweed regions.

Wax from cappings and combs that are melted is not usually sold, but is sent to a manufacturer to be made into comb foundation. However, this wax was valued and credited at the price it would bring on the market.

Bee appreciation represents the amount by which the average fall count of 1931 exceeded the fall count of 1930. In other words, the increases made through package bees bought, colonies and swarms bought, swarms saved, and divisions, more than offset the losses from such causes as winter loss, foulbrood, queenless colonies, and so forth, by an average of 15¢ per colony. There was an actual loss through the year of 20.8% of the colonies. Of this loss, 40.5% was from winter loss, 30.3% from colonies lost by American foulbrood, 3% from spray poison, and the remainder from miscellaneous causes such as theft, queenlessness, flood, bears, and skunks. The replacement of this loss and the slight increase above this loss shown as bee appreciation was made 60% by division, 20% by swarms caught, and 20% by bees purchased.

In addition to the extracted honey there was an average of 2.1 pounds of comb and chunk honey produced per colony, which was sold for 33¢.

Only four apiarists sold queens. Except for one operator, these were sold to neighboring beekeepers. One operator only sold package bees.

REGIONAL COSTS

The cost of producing extracted honey in the different regions is as follows:

Region	Per Colony	Per Pound (Cents)
Alfalfa	$3.86	6.2¢
Fireweed	4.31	6.9
Mixed-blossom	3.08	7.8

The average cost per pound is computed by dividing the net cost per colony by the number of pounds of extracted honey actually extracted, which averaged 62 pounds per colony for the alfalfa region, 62 pounds for the fireweed region, and 39 pounds for the mixed-blossom region.

The cost per pound in the alfalfa region is lower than in the other two regions chiefly because of better honey yields (Table 1). Aside from differences in investment, which have already been discussed, there do not appear to be any major differences in costs per colony in the various regions that are not directly associated with the differences in yield.

THE COST OF PRODUCING COMB HONEY

The net cost of producing comb honey averaged $4.70 per colony, or $2.60 per 24-section case (Table5). Of the gross cost, 51.6% was for labor, 17.6% for materials and supplies, 15.2% for miscellaneous expense, 9.2% for depreciation, and 6.4% for interest.

Table 5. COST OF PRODUCING COMB HONEY, 1931 CROP

Averages for 8 apiarists operating 1,455 colonies, producing 2,628 cases of comb honey. Average number of colonies per operator, 182. Average rate of production, 2¼ cases per colony.*

Cost item	Average cost per colony	Average cost per case **	Percentage of total cost
Labor:			
Hired and contract labor	$ .18	$ .09	2.9%
Operator and family labor	3.02	1.68	48.7
TOTAL	3.20	1.77	51.6
Materials and supplies:			
Section boxes and foundation	.60	.36	9.7
Section shipping cases	.18	.10	2.9
Other materials and supplies	.31	.14	5.0
TOTAL	1.09	.60	17.6
Miscellaneous:			
Use of auto and truck	.47	.29	7.6
Bees and queens purchased	.36	.19	5.8
Other miscellaneous expense	.11	.05	1.8
TOTAL	.94	.53	15.2
TOTAL DEPRECIATION	.57	.31	9.2
TOTAL OPERATING COST	5.80	3.21	93.6
TOTAL INTEREST	.40	.22	6.4
TOTAL GROSS COST	6.20	3.43	100.0
Credit for by-products	1.50	.83	24.2
TOTAL NET COST	$4.70	$2.60	75.8%

* In addition to the 2628 cases of comb honey, some extracted honey was also produced. When this extracted honey is reduced to its equivalent in comb honey by counting each pound of extracted honey as equivalent to one-half pound of comb honey the total production averages 2¼ cases per colony. Each case contained 24 sections of 12 ounces each.

** The average cost per case was computed by dividing the net cost per colony by the number of cases of comb honey actually produced, which averaged 1.8 cases per colony.

Both the gross and the net costs per colony were higher for comb honey than for extracted honey. Labor and supplies cost more and depreciation and interest less per colony for comb honey than for extracted honey, whereas miscellaneous costs happened to be identical.

Inasmuch as only eight comb-honey apiaries are included in this study, the costs shown for comb honey, although indicative, are not nearly so conclusive as are the costs for extracted honey where a large number of records are included.

CASH AND NON-CASH COSTS OF PRODUCING EXTRACTED HONEY

Only a small portion of the cost of producing extracted honey is cash or out-of-pocket cost. Of the gross cost only $1.54 per colony, or 2.5¢ per pound,

was paid out in cash, the remainder representing such items as operator and family labor for which no cash was paid, honey used for bee feed or paid for rent of yards or bees, depreciation, and interest (Table 6).

Table 6. CASH AND NON-CASH COSTS OF PRODUCING EXTRACTED HONEY, 1931 CROP

Cost item	Cash Cost		Non-cash Cost	
	Per colony	Per pound (cents)	Per colony	Per pound (cents)
Labor:				
Hired and contract	$ .22	.3¢	--	
Operator and family	--	--	$1.49	2.5¢
TOTAL	$ .22	.3¢	$1.49	2.5¢
Total materials and supplies	.51	.8	.03	.1
Total miscellaneous	.81	1.4	.13	.2
Total depreciation	--	--	1.00	1.6
Total interest	--	--	.52	.9
TOTAL GROSS COST	$1.54	2.5¢	$3.17	5.3¢
Credit for by-products	.67	1.1	.15	.3
TOTAL NET COST	$ .87	1.4¢	$3.02	5.0¢

It is true, of course, that any such allocation of costs is somewhat arbitrary, for apiarists must earn some wages from their bees in order to meet living expenses; each year they must buy some new equipment, and some may have borrowed money on their bees for which they must pay cash interest. The cash cost shown in Table 6 probably represents the minimum cash outlay that apiarists must make.

In computing the net cash cost, all by-products except bee appreciation were considered as cash credits.

Stated in percentages, only 22.4% of the cost of producing extracted honey is cash outlay and 77.6% is non-cash. Unfortunately many apiarists, if they think of production cost at all, consider only the cash cost. This may explain why some honey producers are always willing to cut prices slightly to get a sale. The mere fact that a few dollars are left over cash expense after the honey crop has been sold does not mean that the sale price exceeds or even equals the total production cost.

VARIATION IN COST OF EXTRACTED HONEY

As already indicated, considerable variation was found in the cost of extracted honey in the three producing regions. This variation was much less, however, than the variation in cost in different apiaries located within the same region. In each region apiaries were found with very low costs and others with very high costs. The amount and extent of these variations is indicated in Table 7, where the costs for all extracted-honey apiaries have been grouped according to the net cost of production. The extreme range in cost was from 2.7¢ to 41¢ per pound.

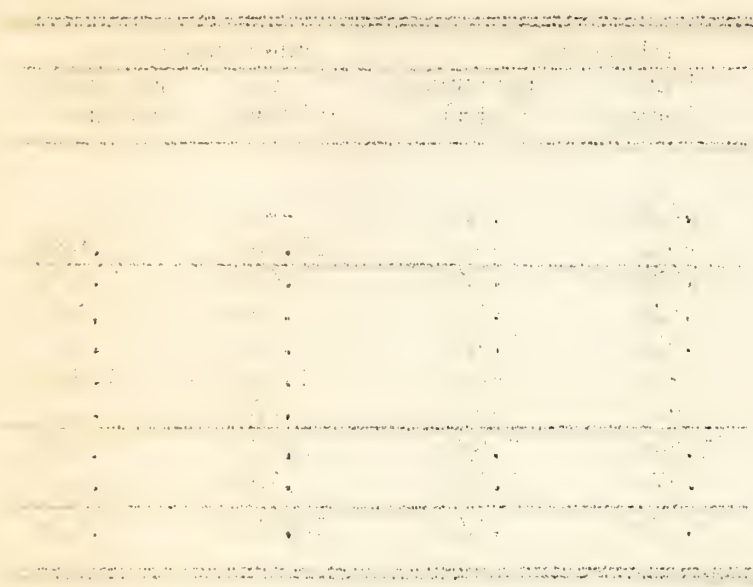


Table 7. VARIATIONS IN THE COST OF PRODUCING EXTRACTED HONEY, 1931 CROP

Cost per pound	Number of records	Average cost per pound	Total number of colonies	Percentage of total colonies	Cumulative percentage of total colonies
Under 4¢	6	3.1¢	1,461	9.0%	9.0%
4 to 5¢	12	4.5	2,732	16.7	25.7
5 to 6¢	9	5.2	1,766	10.8	36.5
6 to 7¢	12	6.6	3,275	20.1	56.6
7 to 8¢	12	7.4	2,145	13.1	69.7
8 to 10¢	15	8.9	1,900	11.6	81.3
10 to 20¢	14	13.2	2,572	15.7	97.0
20¢ and over	5	27.4	497	3.0	100.0
TOTAL OR AVERAGE	85	6.4¢*	16,348	100.0%	--

* This figure is the weighted or true average net cost of production as shown in Table 3.

RELATION BETWEEN COSTS AND PRICES

The prevailing honey price for 1931 was less than the average cost of production. During 1931 the price for carlots of top-grade clover and alfalfa honey f.o.b. shipping point was approximately 5¢ per pound. Wholesale lots of fireweed and mixed-blossom honey were somewhat higher, since most of these sales are made in Portland and the price there, in general, is equal to the price at eastern Oregon points plus freight. Many beekeepers received a higher price than indicated, by canning in small containers and peddling, but this higher price is a reward for marketing effort and in many cases is largely offset by labor and other expense incident to marketing.

Even though the prevailing price and the average cost bear an unfavorable relationship, it is encouraging to note from Table 7 that some beekeepers were still producing at a cost equal to or less than this low price. Approximately 25% of the colonies covered in this study were producing honey at a cost of 5¢ per pound or less. One-fourth of the beekeepers were still operating at a profit in 1931--with the lowest prices known for many years. With normal prices, these producers would make excellent profits. In 1932, however, prices became still lower.

Unfortunately there is a dark side to almost every picture, and honey production is no exception. As shown by Table 7, approximately 18% of the colonies were producing honey at a cost of 10¢ per pound or over. Even in prosperous years carlots of honey sold f.o.b. shipping point do not bring a price as high as this.

THE EFFECT OF YIELD PER COLONY ON PRODUCTION COST

Two of the major objectives of this study are to ascertain why such wide cost variations occur and to recommend adjustments that will enable high-cost producers to lower their costs. As yet the study has not progressed far enough either to determine the major causes of these variations or to justify general recommendations as to the best methods of lowering costs. Only one factor, yield, which is an outstanding factor responsible for cost variation in the production of every agricultural product, will be discussed at this time.

Yield per colony has a decided effect on production cost. Such costs as interest, depreciation, taxes, apiary rent, and so forth are largely constant regardless of the honey crop harvested. As the crop per colony increases, there are more pounds with which to absorb these costs, and hence they become less and less per pound.

Table 8. THE EFFECT OF YIELD ON THE COST OF PRODUCTION OF EXTRACTED HONEY, 1931 CROP

Yield per colony	Number of records	Average yield per colony (pounds)	Cost per colony	Cost per pound (cents)
Below 30 pounds	16	22	$2.68	13.3¢
30 to 60 pounds	28	45	3.57	8.7
60 to 90 pounds	25	72	4.06	6.1
90 pounds and over	16	115	4.99	4.5
TOTAL OR AVERAGE*	85	65	$3.89	6.4¢

* These averages represent the weighted or true average yield and costs, as shown in Table 3.

The effect of yield on the 1931 Oregon honey costs is shown by Table 8. Of the total apiarists cooperating, 16 had yields of less than half a can, averaging 22 pounds per colony. This group had an average cost of 13.3¢ for each pound of honey produced. Another group of 16 cooperators had yields of one and one-half cans or more per colony. The average production for this high-yield crop was 115 pounds of honey per colony, and their average production cost was but 4.5¢ per pound. Is it any wonder that beekeepers are jubilant when they harvest a good yield?

Good yields, while associated with low costs, are not a guarantee of low costs. Sometimes so much is spent in obtaining a good yield that the benefits of this yield are largely or entirely offset. This may happen if bees are moved from one honey flow to another at considerable expense, and the honey obtained does not pay for the labor and other expense of moving. Again, a beekeeper may increase his yield per colony by dividing his colonies into several small yards scattered over a large area, but unless the increase is enough to offset the extra labor and travel cost, this method of increasing yield will also fail to pay.

INDIVIDUAL COST REPORT

At the end of this report is a table designed to supply each cooperating apiarist with a confidential statement of his individual costs. This table is filled out in ink only on the copy of this report returned to the beekeeper cooperating.

It is recognized, of course, that all high-cost producers can not become low-cost producers merely by making a few changes in their management practices, nor will the same adjustment yield the same results for every beekeeper. However, it is believed that a careful study of their individual costs should indicate to many high-cost producers some needed adjustments in their apiaries that will enable them to lower their production costs.

OREGON EXPERIMENT STATION AND
U. S. DEPARTMENT OF AGRICULTURE COOPERATING

Honey Production Cost Study.

CONFIDENTIAL INDIVIDUAL COST REPORT FOR 1931 HONEY CROP

Apiary of _____

Address _____

Cost item	Cost per colony for various yields				Your farm
	Below 30 pounds	30 to 60 pounds	60 to 90 pounds	90 pounds and over	
Labor:					
Preharvest man labor	$1.14	$ .93	$1.30	$1.39	
Harvest man labor	.29	.41	.51	.90	
TOTAL	1.43	1.34	1.81	2.29	
Materials and supplies:					
60-pound cans and cases	.13	.24	.40	.68	
Other materials and supplies	.18	.18	.17	.18	
TOTAL	.31	.42	.57	.86	
Miscellaneous:					
Use of auto and truck	.22	.44	.63	.68	
Taxes	.08	.09	.10	.07	
Apiary rent	.08	.05	.12	.12	
Bees and queens purchased	.18	.17	.07	.20	
Other miscellaneous expense	.18	.18	.32	.20	
TOTAL	.74	.93	1.24	1.27	
Total depreciation	.81	1.10	.95	1.09	
Total interest	.46	.58	.48	.55	
TOTAL GROSS COST	3.75	4.37	5.05	6.06	
Credit for by-products	1.07	.81	.99	1.07	
TOTAL NET COST	2.68	3.56	4.06	4.99	
Average yield per colony	22 lbs.	45 lbs.	72 lbs.	112 lbs.	
TOTAL NET COST PER LB.	13.3¢	8.7¢	6.1¢	4.5¢	
CASH COST PER LB.	1.5¢	1.5¢	1.2¢	1.4¢	

Compare your costs, item by item, with the costs for the group of apiaries with similar yields, as indicated by the red mark under the average yield for this group.

A G R I C U L T U R A L E X P E R I M E N T S T A T I O N

Oregon State Agricultural College
Corvallis, Oregon

Wm. A. Schoenfeld, Director

Circular of Information No. 100 April, 1934

BEE CULTURE LABORATORY
RECEIVED
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U. S. BUREAU OF
ENTOMOLOGY

COST OF PRODUCING HONEY IN OREGON

(For the year 1932)

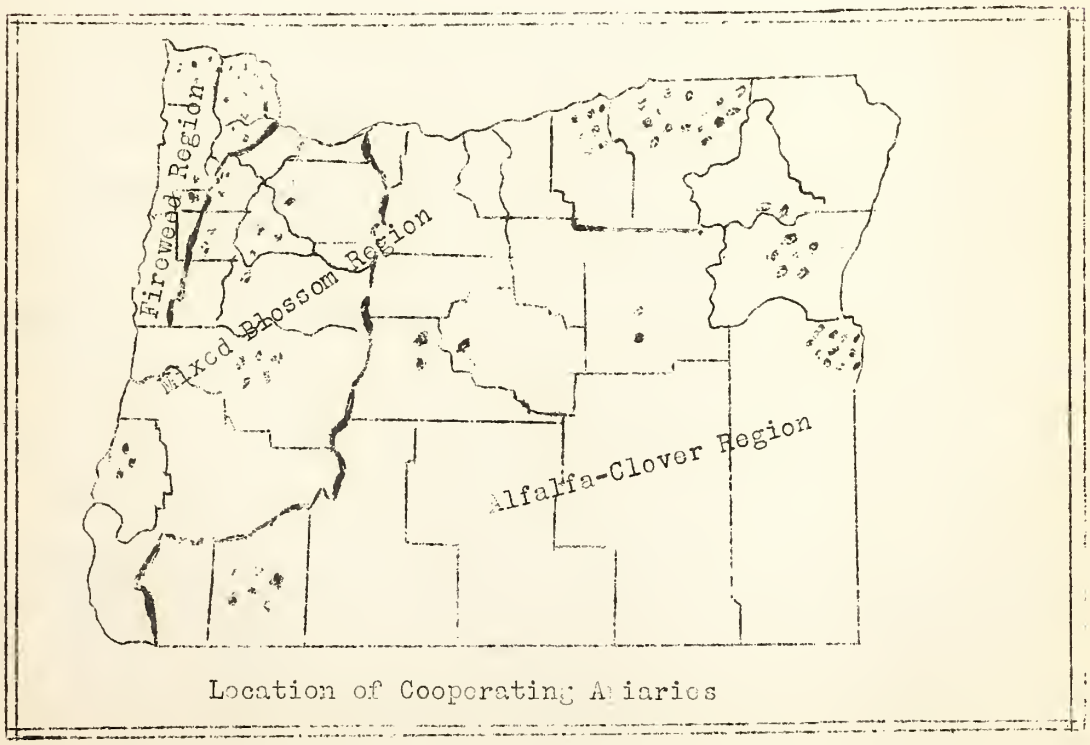
Progress Report No. 2

By

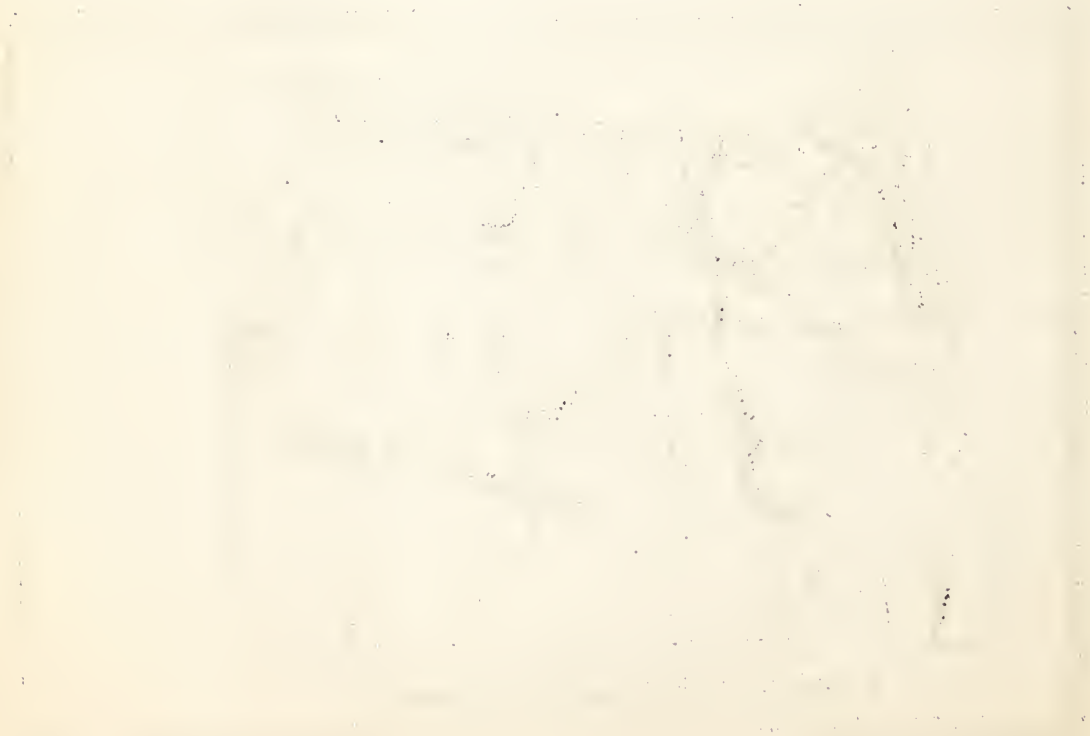
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H. A. Scullen--Associate Professor of Entomology,
Oregon State Agricultural College



Location of Cooperating Apiaries



PROGRESS OF THE STUDY

The Department of Farm Management of the Oregon Agricultural Experiment Station and the Pacific States Bee Culture Field Laboratory, working in cooperation, commenced the economic study of the Oregon honey enterprise reported on herein, during the early spring months of 1932. The major purposes of this study are to determine:

(1) The cost of producing honey in Oregon.

(2) Major and minor factors that influence the cost of producing honey in Oregon.

(3) Practical adjustments which individual beekeepers can make that will enable them to reduce the cost of producing honey.

Collection of cost data from honey producers was started during the early spring months of 1932. At that time data covering the 1931 operations were collected from 93 apiarists, operating 17,803 colonies of bees, which produced 1,099,407 pounds of honey during the 1931 season. These cost records were tabulated and analyzed during the summer and fall of 1932 and in November 1932 the results of this tabulation and analysis were published in mimeograph form in Oregon Experiment Station Circular of Information No. 83 (Progress Report No. 1).

During the spring of 1933 additional cost data were collected. These data cover the 1932 crop and were supplied by 87 apiarists operating 16,476 colonies which in 1932 produced a crop of 1,083,261 pounds of honey. Of these 87 cooperators all but 7 also cooperated in supplying cost data for the 1931 crop, the analysis of which is reported in Progress Report No. 1.

This report (Progress Report No. 2) is devoted to an analysis of the

ACKNOWLEDGMENTS: The authors wish to express their sincere appreciation for the excellent cooperation received from the beekeepers participating in this study. They also wish to express their appreciation and thanks to H. D. Scudder, Economist in Farm Management, Oregon Agricultural Experiment Station, and to E. L. Sechrist, Associate Apiculturist, Pacific States Bee Culture Field Laboratory, Bureau of Entomology, U. S. Department of Agriculture, for many helpful suggestions and for valuable aid in preparing the field schedule.

1932 cost records and a comparison of the 1932 and the 1931 costs. In order to avoid duplication much of the detailed and descriptive discussion presented in the first Progress Report is omitted. Where readers have a copy of Progress Report No. 1 available it is suggested that this be reviewed prior to reading this report as a more thorough understanding of the study is likely to result.

The location of the beekeepers cooperating in this study is shown by the map on the cover page. The regional distribution of these apiaries, the total colonies operated, and the total quantities of honey produced in 1932 are shown in Table 1.

Table 1. REGIONAL DISTRIBUTION OF HONEY COST RECORDS, 1932 CROP

Region	Cooperators		Colonies of bees		Total honey produced*		Average number of colonies per beekeeper	Yield of extracted honey per colony (pounds)**
	Number	% of total	Number	% of total	Pounds	% of total		
Alfalfa-clover	48	55.2	11,946	72.4	834,684	77.0	249	74
Firewood	20	23.0	2,807	17.1	146,998	13.6	140	53
Mixed blossom	19	21.8	1,723	10.5	101,579	9.4	91	62
TOTAL OR AVERAGE	87	100.0	16,476	100.0	1,083,261	100.0	189	69

*Includes both extracted and comb honey produced by all 87 apiaries. Of these, 78 were producing chiefly extracted honey and 9 were producing chiefly comb honey.

**Includes only the 78 apiaries producing extracted honey as a major product. These yields were obtained by dividing the equivalent in extracted honey of the total quantity of comb and extracted honey produced by the total number of colonies in these apiaries. See Table 3.

THE BEE INTERPRISE INVESTMENT

The itemized investment in the bee enterprise is shown in Table 2. Only 9 comb-honey records are included in this study; so the average investment

for comb-honey apiaries is not so conclusive as the average investment shown for the extracted-honey apiaries, and except in a very general manner these figures are not suitable for comparing the investment requirements of comb and extracted honey production.

The investment for apiaries producing extracted honey averaged 90 cents per colony less in 1932 than in 1931. Of this decrease 75 cents, or 83%, was in the value of the bees. At the close of the 1932 season many beekeepers, discouraged because of a long period of low prices and slow sales, were inclined to consider their bees worth less than a year previously. Furthermore, aside from comb foundation, which was cheaper than it had been for several years, very little permanent equipment was purchased and normal depreciation was not met. As a result, in addition to the lower valuation of the bees, there was a net loss of 15 cents per colony in the other items of bee investment.

Table 2. CAPITAL INVESTED IN THE BEE ENTERPRISE, 1932*

Investment	Apiaries producing extracted honey			Apiaries producing comb honey-Average per colony
	Average per operator	Average per colony	Percentage of total	
Bees	$ 385	$ 2.01	21.0%	$ 2.11
Hives and Parts	635	3.32	34.6	2.40
Combs	487	2.54	26.5	.81
Miscellaneous equipment	105	.55	5.8	.46
Harvesting equipment	105	.55	5.8	.14
Buildings	108	.55	5.8	.66
Apiary sites	10	.05	.5	.06
TOTAL INVESTMENT-1932	$1835	$ 9.57	100.0%	$ 6.64
TOTAL INVESTMENT-1931	$2014	$10.47	100.0%	$ 8.01

*The values shown in this table, with the exception of the bees and apiary sites, represent the present depreciated values of these items.

REGIONAL INVESTMENT

For the two years covered by the study the regional investment per colony for apiaries producing extracted honey was as follows:

	1931	1932	Difference
Alfalfa-clover region	$ 9.55	$ 8.60	$0.95
Mixed-blossom region	11.20	10.28	.92
Fireweed region	13.48	12.90	.58

The explanation of the regional differences in investment was given in Progress Report No. 1 and will not be repeated here. The three regions maintained about the same relationship to each other in 1932 as in 1931. In the fireweed region the decrease in investment per colony from 1931 to 1932 was less than in the other two regions, owing to a heavy increase in stocks of drawn comb, which offset decreases in bee value and depreciation on hives and parts, harvesting and miscellaneous equipment.

THE COST OF PRODUCING EXTRACTED HONEY

The net cost of producing extracted honey in 1932 for the 78 apiaries producing this type of honey averaged $3.80 per colony and 5.7 cents per pound of honey (Table 3). The gross cost averaged $4.25 per colony, but, in addition to the extracted honey, certain by-products (Table 4) were also produced, and the value of these must be credited before the net cost of the honey can be ascertained. Both the gross and net costs, as presented, are for honey extracted, canned in 60-pound cans, and cased in 2-can cases.

Each apiarist operated an average of 191 colonies and each colony produced at the average rate of 69 pounds of surplus extracted honey in addition to the regular winter stores. In computing this yield, each pound of comb or cut-comb honey was counted as the equivalent of 2 pounds of extracted honey, but in computing the cost per pound only honey actually

extracted was considered, as the value of the comb and cut-comb honey produced is included in the by-product credits.

THE 1932 AND 1931 COSTS COMPARED

The total net cost for 1932 averaged only 9 cents per colony less than in 1931, but because of a higher yield of honey (69 pounds per colony as compared with 65 pounds in 1931) the average net cost per pound was practically three-fourths of a cent less than in 1931.

The net reduction for the items comprising the gross cost of producing honey averaged 46 cents per colony and 1.4 cents per pound. However, the by-products produced along with the extracted honey were worth less in 1932 than in 1931; so only a portion of this reduction in gross cost could be carried along to the net cost. A comparison of the major items of cost shows that in 1932 labor, miscellaneous expense, interest, and by-product credits were less per colony than in 1931, while depreciation was more than in 1931 and materials and supplies were the same during both years.

The decrease in labor cost was due both to a decrease of one tenth hour per colony in the amount of labor and to a lower estimated value for all labor. In 1932 hired labor cost on the average 22.1 cents per hour and the labor of the operator and his family was valued at 30.0 cents per hour, while in 1931 hired labor cost 27.8 cents per hour and operator and family labor was valued at 36.8 cents per hour. The cost of labor will naturally vary from year to year with changes in the general economic condition of the country, but it is noteworthy that during the two years of the study the average quantity of labor showed but little variation.

The decrease in cost of miscellaneous items is the only other variation of any significance among the five cost groups making up the

Table 3. COST OF PRODUCING EXTRACTED HONEY, 1932 CROP

Averages for 78 apiarists, operating 14,918 colonies and producing 992,957 pounds of extracted honey. Average number of colonies per operator, 191. Average rate of production per colony, 69 pounds. *

Cost Item	Average cost per colony	Average cost per pound **	Percent of total cost
Labor:			
Hired and contract	$ .21	.3¢	4.9%
Operator and family	1.17	1.8	27.5
TOTAL	1.38	2.1	32.4
Materials and supplies:			
60-pound cans and cases	.41	.6	9.6
Bee feed (honey and sugar)	.05	.1	1.2
Section boxes and foundation	.02	-	.5
Power and fuel	.04	.1	.9
Other material and supplies	.02	-	.5
TOTAL	.54	.8	12.7
Miscellaneous:			
Use of auto or truck	.41	.6	9.6
Taxes	.07	.1	1.7
Apiary rent	.07	.1	1.7
Bees and queens purchased	.09	.2	2.1
Rent of bees	.03	-	.7
Other miscellaneous expense	.03	-	.7
TOTAL	.70	1.0	16.5
Depreciation:			
Hives and parts	.37	.6	8.7
Combs	.65	.9	15.4
Miscellaneous equipment	.04	.1	.9
Harvest equipment and supplies	.05	.1	1.2
Buildings	.04	.1	.9
TOTAL	1.15	1.8	27.1
TOTAL OPERATING COST	$3.77	5.7¢	88.7%
Interest (at 5%)			
Bees	.10	.2	2.3
Hives and parts	.16	.2	3.8
Combs	.13	.2	3.1
Miscellaneous equipment, supplies, harvest equipment, buildings, and apiary sites	.09	.1	2.1
TOTAL	.48	.7	11.3
TOTAL GROSS COST	$4.25	6.4¢	100.0
Credit for by-products	.45	.7	10.6
TOTAL NET COST -1932 CROP	$3.80	5.7¢	89.4%
TOTAL NET COST -1931 CROP	$3.89	6.4¢	82.6%

* In addition to the extracted honey, small quantities of comb and cut-comb honey were also produced, making a total production equivalent to 1,025,613 pounds of extracted honey, where each pound of comb or chunk honey is counted as the equivalent of two pounds of extracted honey.

** The average cost per pound was computed by dividing the cost per colony by the quantity of honey that was actually extracted, which averaged 67 pounds per colony. Comb and cut-comb honey was credited to the gross cost as a by-product.

gross cost. While cost reductions occurred for every subitem in this group, practically half of the total reduction was in the cost for auto and truck use. On the average auto and truck expense constitute about 10 per cent of the gross cost of honey production, and furthermore a large portion of this item (the operating expense of these machines) is cash outlay. Because of this fact it is of considerable significance that a substantial reduction occurred in this item.

Table 4. VALUE OF BY-PRODUCTS OF EXTRACTED HONEY, 1932 CROP

Item	Average per colony	Average per pound of honey	Percentage of total
Pollination	$0.10	.2¢	22.2%
Wax	.14	.2	31.1
Bee appreciation	.04	.1	8.9
Comb and chunk honey	.14	.2	31.1
Queens and package bees	.03	-	6.7
TOTAL BY-PRODUCTS - 1932 CROP	$ .45	.7¢	100.0%
TOTAL BY-PRODUCTS -1931 CROP	$ .82	1.4¢	100.0%

Each item in the group of by-products credits, with the exception of queens and package bees, was less in 1932 than 1931. There was less renting for pollination, and collections on bees that were rented were very poor. Wax and comb honey was worth less in 1932 than in 1931. Increases in colony numbers barely offset losses; hence there were less credits for bee appreciation.

REGIONAL COSTS

The net cost of producing honey in the different regions during 1932 and 1931 was as follows:

Region	Honey extracted Per colony		Cost Per colony		Cost Per pound	
	1931	1932	1931	1932	1931	1932
Alfalfa-clover	62 lbs.	72 lbs.	$3.86	$3.53	6.2¢	4.9¢
Fireweed	62	52	4.31	4.81	6.9	9.3
Mixed blossom	39	57	3.08	3.85	7.8	6.7
ALL REGIONS	61 lbs.	67 lbs.	$3.89	$3.80	6.4¢	5.7¢

The average cost per pound is computed by dividing the net cost per colony by the number of pounds of honey actually extracted. The total yield per colony, which includes an allowance for comb and cut-comb honey produced, is shown in Table 1.

While for the State as a whole the per-colony and per-pound costs were less in 1932 than 1931, because of reasons previously discussed, in both the fireweed and mixed-blossom regions the per-colony costs were higher in 1932 than in 1931. In the fireweed region this increase in cost was due to a large decrease in credits for by-products, the gross cost in 1932 being 19 cents per colony less than in 1931. Furthermore, owing to a lower average yield, the cost per pound was considerably higher than in 1931. In the mixed-blossom region the increased cost per colony appears to be due to (1) a larger crop of honey per colony which increased the cost for harvesting labor, honey containers, auto and truck use, and so forth; and (2) a slight decrease in by-product credits. Because of the better yield, however, the cost per pound in this region was less than in 1931.

COST OF PRODUCING COMB HONEY

The net cost of producing comb honey in 1932 averaged $3.73 per colony and $1.91 per case. The yield of comb honey per colony in 1932 was practically identical with the 1931 yield. Net cost per colony and per case, however, was much less than in 1931.

Only a limited number of comb-honey records were included in this study; hence these differences in cost are of less significance than for the extracted honey apiaries. It is of interest, however, that comb honey

Table 5. COST OF PRODUCING COMB HONEY, 1932 CROP

Averages for 9 apiarists operating 1558 colonies, producing 2929 cases of comb honey. Average number of colonies per operator, 173. Average rate of production, 2.26 cases per colony. *

Cost item	Average cost per colony	Average cost per case	Percentage of total cost
Labor:			
Hired and contract labor	$ .06	$ .03	1.3%
Operator and family labor	2.16	1.15	47.0
TOTAL LABOR	$2.22	$1.18	48.3
Materials and supplies:			
Section boxes and foundation	.49	.26	10.7
Section shipping cases	.17	.09	3.7
Other materials and supplies	.14	.07	3.0
TOTAL MATERIALS AND SUPPLIES	.80	$ .42	17.4
Miscellaneous:			
Use of auto and truck	.50	.23	10.8
Bees and queens purchased	.05	.02	1.1
Taxes	.06	.03	1.3
Other miscellaneous expense	.04	.02	.9
TOTAL MISCELLANEOUS	.65	$ .35	14.1
TOTAL DEPRECIATION	.60	.32	13.0
TOTAL OPERATING COST	4.25	2.27	92.8
TOTAL INTEREST	.33	.18	7.2
TOTAL GROSS COST	$4.60	$2.45	100.0
Credit for by-products	.87	.54	18.9
TOTAL NET COST - 1932 CROP	$3.73	$1.91	81.1%
TOTAL NET COST - 1931 CROP	$4.70	$2.60	75.8%

* In addition to the 2929 cases of comb honey, some extracted honey was also produced. When this extracted honey is reduced to its equivalent in comb honey by counting each pound of extracted honey as equivalent to one-half pound of comb honey, the total production averages 2.26 cases per colony. Each case contained 24 sections.

** The average cost per case was computed by dividing the net cost per colony by the actual number of cases of comb honey produced, which averaged 1.88 cases per colony.

was produced in 1932 with 2 hours' less labor per colony than in 1931, and that the reduction in amount of labor plus the reduction due to a lower value for labor accounts for a major share of the variation shown in net cost.

CASH AND NON-CASH COSTS OF PRODUCING EXTRACTED HONEY

The cash and non-cash costs of producing extracted honey are shown in Table 6. Of the total 1932 cost of $3.80 per colony and 5.7 cents per pound, only 93 cents per colony and 1.3 cents per pound, or 24.5% of total cost, is cash or out-of-pocket cost. These costs are similar to the cash costs for the 1931 crop. Most of the reduction in cost that occurred between 1931 and 1932 was in non-cash items, chiefly operator and family labor.

Table 6. CASH AND NON-CASH COSTS OF PRODUCING EXTRACTED HONEY, 1932 CROP

Cost Item	Cash cost		Non-cash Cost	
	Per colony	Per pound (cents)	Per colony	Per pound (cents)
Labor:				
Hired and contract	$ .21	.3¢	-	-
Operator and family	-	-	$1.17	1.8¢
TOTAL	$ .21	.3¢	$1.17	1.8¢
Total materials and supplies	.51	.8	.03	-
Total miscellaneous	.62	.9	.08	.1
Total depreciation	-	-	1.15	1.8
Total interest	-	-	.48	.7
TOTAL GROSS COST	$1.34	2.0¢	$2.91	4.4¢
Credit for by-products	.41	.7	.04	-
TOTAL NET COST - 1932 CROP	$ .93	1.3¢	$2.87	4.4¢
TOTAL NET COST - 1931 CROP	$ .87	1.4¢	$3.02	5.0¢

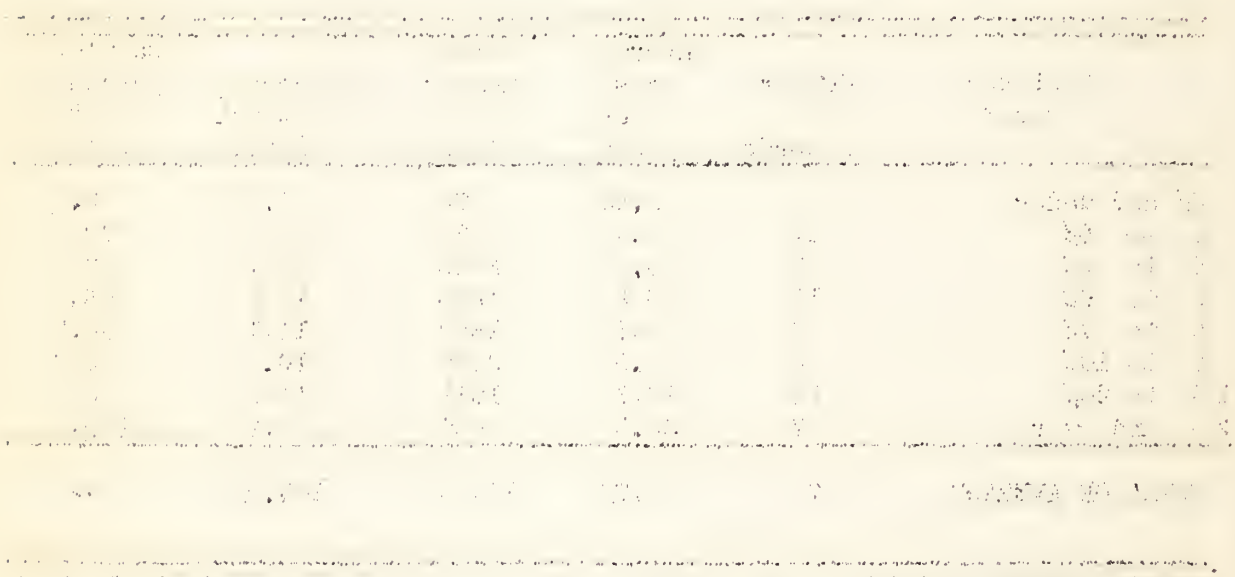
VARIATION IN THE COST OF EXTRACTED HONEY

As already indicated, both in 1931 and 1932 considerable variation was found in the cost of extracted honey in the three producing regions. This variation was much less, however, than the variation in cost in different apiaries located within the same region. In each region apiaries were found with very low costs and others with very high costs. The amount and extent of these variations for 1932 is indicated in Table 7, where the costs for all extracted-honey apiaries have been grouped according to the net cost of production. The extreme range in cost was from 1.9 cents to 42.4 cents per pound.

Table 7. VARIATIONS IN THE COST OF PRODUCING EXTRACTED HONEY, 1932 CROP

Cost per pound	Number of records	Average cost per pound	Total number of colonies	Percentage of total colonies	Cumulative percentage of total colonies
3¢ and under	5	2.6¢	575	3.9%	3.9%
3 to 4¢	17	3.4	3721	24.9	28.8
4 to 5¢	9	4.6	2038	13.7	42.5
5 to 6¢	10	5.2	1885	12.6	55.1
6 to 7¢	8	6.6	1658	11.1	66.2
7 to 10¢	8	9.0	2440	16.4	82.6
10 to 20¢	14	13.7	1671	11.2	93.8
20 and over	7	35.5	930	6.2	100.0
TOTAL OR AVERAGE	783	5.7¢	14918	100.0%	--

As stated in the opening pages of this report, a major objective of this study was to point out the reasons for the wide cost variations between producers. In 1931 approximately 25% of the beekeepers were producing honey at a net cost of less than 5 cents per pound while in 1932 a total of 42.5% were producing at a net cost of 5 cents per pound and under. When such a large proportion of the beekeepers can produce at these low costs, it would appear that high cost producers could well afford to give serious attention to the major factors that affect cost.



THE EFFECT OF YIELD ON PRODUCTION COST

There is no question about the dominant effect of yield on production cost. Such costs as interest, depreciation, taxes, apiary rent, and so forth are largely constant regardless of the honey crop harvested. As the crop per colony increases, there are more pounds with which to absorb these costs, and hence they become less and less per pound.

The effect of variation in yield on the costs of producing the 1932 honey crop is shown in Table 8.

Table 8. THE EFFECT OF YIELD ON THE COST OF PRODUCTION OF EXTRACTED HONEY, 1932 CROP

Yield per colony	Number of records	Average yield per colony (pounds)	Cost per colony	Cost per pound (cents)
Below 30 pounds	16	17	$3.05	18.0¢
30 to 60 pounds	20	45	3.93	9.1
60 to 90 pounds	22	76	3.52	4.7
90 pounds and over	20	115	4.40	4.0
TOTAL OR AVERAGE	78	69	$3.80	5.7¢

FACTORS AFFECTING YIELD

What procedure can the individual beekeeper follow to obtain increased yield? Obviously the first consideration is to locate his colonies where ample bee pasture is available. The next step, which involves many factors, is so to manipulate his bees that a maximum harvest of this honey will result. Almost any healthy colony of bees located near good bee pasture will store surplus honey, but only the colonies that have a maximum bee population ready to work when the nectar is ready to be gathered can be expected to put up the maximum crop.

Analysis of such factors as the effect of foulbrood, the queening practice followed, the amount of swarming, the amount of care prior to harvest, and other pertinent factors that have a bearing on possible yields is now being carried on and will be reported in the final bulletin on this study, which will be issued as soon as possible.

INDIVIDUAL COST REPORT

At the end of this report is a table designed to supply each cooperating apiarist with a confidential statement of his individual costs. This table is filled out in ink only on the copy of this report returned to the beekeeper cooperating.

It is recognized, of course, that all high-cost producers can not become low-cost producers merely by making a few changes in their management practices, nor will the same adjustment yield the same results for every beekeeper.

However, it is believed that a careful study of their individual costs should indicate to many high-cost producers some needed adjustments in their apiaries that will enable them to lower their production costs.

Oregon Experiment Station and
U. S. Department of Agriculture Cooperating

HONEY PRODUCTION COST STUDY

Confidential Individual Cost Report for 1932 Crop

Apiary of _____

Address _____

Cost Item	Average Cost Per Colony* Alfalfa Region	Mixed Blossom Region	Fireweed Region	Your Farm
Labor				
Pre-harvest man labor	$ .75	$1.18	$1.23	
Harvest man labor	.55	.42	.34	
TOTAL LABOR	$1.30	$1.60	$1.57	
Materials				
60 pound cans and cases	.46	.32	.30	
Other materials and supplies	.13	.16	.10	
TOTAL MATERIALS	$ .59	$ .48	$ .40	
Miscellaneous				
Use of auto and truck	.34	.58	.53	
Taxes	.08	.06	.03	
Apiary rent	.06	.08	.10	
Bees and queens purchased	.05	.12	.16	
Other miscellaneous expense	.13	.29	.56	
TOTAL MISCELLANEOUS	$ .66	$1.13	$1.38	
TOTAL DEPRECIATION	$1.12	$1.01	$1.35	
TOTAL INTEREST	$ .43	$ .51	$ .65	
TOTAL GROSS COST	$4.10	$4.73	$5.35	
Credit for by-products	.57	.88	.54	
TOTAL NET COST	$3.53	$3.85	$4.81	
TOTAL NET COST PER POUND	4.9¢	6.7¢	9.3¢	
Cash Cost per Pound	1.3¢	1.3¢	1.9¢	
Colonies Per Operator	245	99	146	
Average Yield Per Colony	74 lbs.	62 lbs.	53 lbs.	

* The Data shown in this table apply only to the 78 apiaries producing extracted honey as the main product.

UNITED STATES DEPARTMENT OF AGRICULTURE
EXTENSION SERVICE, C.W. WARBURTON, DIRECTOR—OFFICE OF COOPERATIVE EXTENSION WORK, C.B. SMITH, CHIEF

LANTERN SLIDE — THE ANATOMY OF THE HONEY BEE — SERIES 151

This series of slides; supplementing Technical Series No. 18, The Anatomy of the Honeybee, and illustrating the anatomy of the honeybee, is prepared from illustrations selected by and arranged in cooperation with the Bureau of Entomology, and includes 31 slides. Supplementary notes prepared by the Bureau of Entomology are attached.

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1	S-1659	Title slide.
2	23816-B	Credit slide.
3	23597-B	The egg, larva and pupa of the honeybee.
4	23598-B	Side view of larva showing tracheal system.
5	23599-B	Section of entire body of the worker bee.
6	23600-B	Face of bee with front, antennae and proboscis removed.
7	23601-B	Head of worker bee with mouth parts cut off a short distance from their bases.
8	23602-B	Mouth parts of the worker.
9	23603-B	Median longitudinal section of head of worker, but with entire labium attached, showing internal organs except muscles and brain.
10	23604-B	Dorsal view of ventral walls and internal skeleton of body of worker.
11	23605-B	Wings of the honeybee.
12	23606-B	The legs of the honeybee.
13	23607-B	The hind leg of the worker.
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15	23609-B	Outer view of hind claw of worker, queen and drone.
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Slide number	Negative number	
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18	23612-B	Tip of abdomen of worker with left side removed.
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20	23614-B	Ventral view of sting of worker and accessory parts flattened out.
21	23615-B	Details of sting of worker.
22	23616-B	The alimentary canal and its glands.
23	23617-B	The honey stomach of worker, queen and drone.
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25	23619-B	Longitudinal, median vertical section of entire body of worker.
26	23620-B	Nervous system of worker - dorsal view.
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28	23622-B	Horizontal section of compound eye and optic lobe of worker.
29	23623-B	Worker, queen and drone of honeybee.
30	23624-B	The reproductive organs of the drone.
31	23625-B	The reproductive organs of the queen.

Supplementary Notes for Lantern-Slide Series 151

THE ANATOMY OF THE HONEYBEE

Prepared by
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Note: These notes were prepared by the Bureau of Entomology to accompany Lantern-Slide Series 151, The Anatomy of the Honeybee, which supplements Technical Series No. 18, The Anatomy of the Honeybee. This series is available for distribution by the Office of Cooperative Extension Work, Extension Service, U. S. Department of Agriculture, under cooperative agreement with the Bureau of Entomology. Slides should be returned after using to the Office of Cooperative Extension Work, Extension Service, U. S. Department of Agriculture, Washington, D.C.

INTRODUCTION

The anatomy of the honeybee is a subject of much interest to those engaged in beekeeping either for pleasure or for profit. This interest is due not only to a desire to know more of the bee, but to the necessity of such information in order to understand what takes place in the colony. Since all practical manipulations depend on an understanding of the behavior and physiology of bees under varying conditions, those beekeepers who have advanced beekeeping most are those who know most of bee activity. In turn, a knowledge of bee activity must rest largely on a knowledge of the structure of the adult bee.

1. (S-1659) Title slide.

The popular demand for information about bees leads many untrained men to write on the subject, and most accounts of bee anatomy contain numerous errors. The drawings presented in this lecture are selected from "THE ANATOMY OF THE HONEYBEE" by R. E. Snodgrass of the U. S. Bureau of Entomology and the text is largely a condensation of this bulletin. These drawings furnish better information of the anatomy of the bee than has heretofore been offered.

2. (20280-B) Credit slide.

GENERAL STRUCTURE OF THE HONEYBEE

When we think of an animal, whether a bee, a fish, or dog, we unconsciously assume that it possesses organs which perform the same vital functions with which we are acquainted in ourselves. Our chief interest, however, in any animal lies in the fact that it lives and moves rather than that it has legs or a stomach of a certain structure and form, yet we want to know something of the structure of the bee in order that we may understand how it lives and moves. In studying the honeybee we shall find that it possesses mouth parts for taking up raw food, an alimentary canal to digest it, salivary glands to furnish a digestive liquid, a contractile heart to keep the blood in circulation, a respiratory system to furnish fresh oxygen and carry off waste gases, excretory organs for eliminating waste substances from the blood, a nervous system to regulate and control all other parts, and finally, organs to produce the reproductive elements from which new individuals are formed to take the place of those that die.

3. (23597-B) The egg, larva and pupa of the honeybee.

Since all animals originate in an egg, the change into the adult involves two different processes: One is growth, which is merely increase in size, the addition of material to material; the other is development, which means change in shape and production of a form with complex organs from the simple material of the egg. The part of the development that takes place within the eggshell is known as embryonic development. In the bee there are two later stages of development, an active one called the larval stage and an inactive one called the pupal stage. During the first of these the young insect is termed a larva; during the second, a pupa. The final and fully developed form is an adult, or imago.

4. (23598-B) Side view of larva showing tracheal system. (Nelson's Embryology of the Honey Bee, Fig. 63.)

When the embryo in its course of development first takes on a form suggestive of an insect, it consists of a series of segaments, and shows no differentiation into head, thoracic and abdominal regions. Many of the segaments are provided with appendages, small rounded protuberances, destined to form mouth parts, antennae, legs, or wings. Within the embryo are the rudiments of the various organs of the adult.* The tracheal system, as a branched tube, may be seen readily, in the larva, in some stages of European foulbrood.

5. (23599-B) Section of entire body of the worker bee. (Snodgrass Fig. 1)

In the adult bee, the body wall is hard on account of the thick layer of chitin (kitin), which exists on the outer side of the true skin. Chitin is a substance similar to horn, being brittle, tough, and elastic. It gives form and rigidity to the body and affords a solid attachment for

*Asterisk indicates place where slide may be commented on.

the muscles within, since the bee has no internal frame-work of bones such as vertebrate animals have. The skin between the segments is soft and unchitinized a flexible membrane which, in the abdomen, allows each segment (III, IV, V, VI) to telescope into the one in front of it. The chitin of each segment is not continuous, but is divided into a series of plates, usually separated by membranous lines which permit of more or less movement between the plates. Since there is no internal skeleton, the joints are formed by two closely articulated chitinous parts movable upon each other simply by a flexible, membranous, hinge-like attachment.*

The head of the bee is a composite organ formed of six or seven primitive segments, the antennae being developed from the embryonic appendages of one segment, the mandibles from another, and so on.

6. (23600-B) Face of bee, with front, antennae, and proboscis removed. (Snodgrass Fig. 10)

The worker, queen and drone differ conspicuously in the shape and size of the head, as will be seen by comparing the figures. The front parts have been removed to show various internal organs. The head of the worker is triangular in facial view, that of the queen is more rounded and wider in proportion to its length but is smaller than that of the worker, while the head of the drone is much larger and varies greatly from the female's in that the eyes of the drone are enormously larger, coming quite together on top and on the upper part of the front of the head. The mandibles of the drone and queen are notched while the mandibles of the worker are hollowed out and have smooth and rounded edges.* The parts of the proboscis are much longer in the worker than in the drone and queen which are almost entirely dependent upon the workers for food.

7. (23601-B) Head of worker bee with mouth parts cut off a short distance from their bases. (Snodgrass Fig. 9)

The general appearance of the head of a worker bee is shown from before and behind. In facial view the head is triangular with the apex below. The side angles are rounded and capped by large compound eyes. In the other direction the head is very much flattened, the face being convex while the posterior surface is hollowed out to fit the thorax snugly. The large eyes are called compound eyes, because each is composed of a number of separate eye elements forming the little hexagonal facets visible on the surface. All this eye surface is densely clothed with fine hairs. On the top of the head are three simple eyes arranged in a triangle.*

Below the lower halves of the large eyes are the antennae, consisting of a long basal stalk carrying a terminal eleven-jointed arm. (In the drone this terminal arm consists of 12 joints.)

The MOUTH PARTS are at the lower part of the head and consist of the mandibles. Under and between the mandibles lie the parts which include the blade-like organs surrounding the protrusible "tongue", constituting together what is known as a proboscis. When not in use the proboscis is bent back beneath the head. Between the mandibles on the front of the head is the upper lip beneath which lies the mouth.

THE ANTENNAE. Each antenna is a hollow tube containing a large nerve, minute extensions of the breathing system and the small muscles which move it. The popular name "feelers" is a good one for these appendages because they are constantly moved around in a nervous sort of way as if the bee were feeling its way along by means of them. There can be no doubt that the sense of touch is highly developed inthem and that by means of them the bees acquire a great deal of information concerning their surroundings and their companions. Whileit can be stated positively that insects perceive differences of touch, taste, smell, sound, and light, and act accordingly, we can not say what the sensations they acquire are like. In fact we do not know that they have conscious sensations at all. What looks like an action due to intelligent perception may be purely a reflex one, unaccompanied by any sensation. The question whether bees are possessed of consciousness or not, is one which can be answered neither one way nor the other.

THE MANDIBLES are the dark, strong chitinous appendages of the head, commonly called jaws, situated at each side of the mouth, anterior to the base of the proboscis. The mandibles are arranged on only a hinge joint. Therefore the bee can only bite and crush its food, not really chew it. Besides the use of the mandibles for eating pollen they serve as tools for manipulating and modeling wax. Because of the structure of the mandibles the worker bee does not puncture fruit, as is sometimes claimed.

THE PROBOSCIS. The group of mouth appendages in the honeybee form what is known as the proboscis by means of which the bee takes up liquid food.

8. (23602-B) Mouth parts of the worker. (Snodgrass Fig. 15)

By separating the parts of the proboscis a little it will be seen that there is a central, slender, flexible organ commonly called the tongue, although it is not a true tongue.* The tip of the tongue is a small spoon-shaped lobe while the remainder of the tongue is covered by fringes of converging hairs. It lies between two other parts which fit it closely, forming the labium. The labium, in turn, lies between the maxillae which form a tube around the labium. When not inuse the proboscis is folded down beneath the head, but when the bee wishes to take up liquid like honey or sirup, the parts are straightened out and held close together so as to form a tube leading to the mouth, the labium with the tongue within it lying between the maxillae.

The action of the mouth parts while feeding may be observed easily if some bees are given a small amount of honey and then watched through a lens while they are eating. A convenient method is to put a few workers in a small screen-covered cage, such as a queen cage, spread a drop of honey on the wire and then place the cage under a simple microscope.

It will be seen that the entire labium slides back and forth between the other parts of the proboscis with a very regular to-and-fro movement as if the honey were being either pumped or sucked up into the mouth. The liquid undoubtedly runs up the temporary tube between the blades to the mouth by capillary attraction, but it is assisted on its way by the movement of the labium. The load brought up when the labium is pulled back is then sucked into the mouth by the pharynx while the labium again goes out after more.

Besides this motion of the entire labium, the tongue itself performs a conspicuous independent movement of its own. It is the most active member of the mouth parts during feeding, being constantly thrust out and retracted while its tip is constantly moved about in a way suggestive of its being delicately perceptive of taste or touch or perhaps to both of these senses. It is supposed that the delicate tongue also takes up the smallest drops of nectar, quantities that would be lost in the clumsy tube formed between the parts of the labium and maxillae. Since, the tongue, covered with hair, is also capable of being shortened upon itself and consequently thickened, the hair becoming bushy, it must assist in carrying the nectar through the channels and into the mouth. The proboscis of both drone and queen are smaller and weaker than those of the worker, and neither of these two is capable of feeding itself to any extent. If a hungry queen be given some honey she attempts to eat it and does imbibe a small quantity, but at the same time she gets it very much smeared over her head and thorax.

9. (23603-B) Median longitudinal section of head of worker, but with entire labium attached, showing internal organs except muscles and brain. (Snodgrass Fig. 19)

The bee also has SALIVARY GLANDS which lie within the head and thorax opening at a point which enables the saliva to be mixed with the food before it enters the mouth. This is necessary since the jaws, or mandibles, are also on the outside of the mouth.* Bees appear to have the power of letting the saliva run down the tongue when necessary to dissolve a hard substance like sugar and render it capable of being taken up in solution, for they do not eat sugar with their mandibles. Moreover, there is a sort of pump at the termination of the salivary duct, by means of which the secretion can be forcibly ejected upon the base of the tongue.

10. (23604-B) Dorsal view of ventral walls and internal skeleton of body of worker. (Snodgrass Fig. 20)

The THORAX or middle division of the body carries on it the wings and legs. Within it are the large muscles for the movement of the wings as well as several glands and some parts of the respiratory and circulative systems.*

11. (23605-B) Wings of the honeybee. (Snodgrass Fig. 25)

WINGS. Bees and other Hymenoptera have four wings. In bees, the hind wings are very small and are, normally, attached by small hooks to a thickened edge of the front wings, so that both wings can act together perfectly.* The motion of the wing in flight consists of an up-and-down and a forward-and-backward movement which two combined cause the tip of the wing to describe a figure-eight course if the bee is held stationary. Four corresponding sets of muscles are connected with the wings. Because of the enormous development of the two main sets of flight muscles, bees are capable of strong and rapid flight.

12. (23606-B) The legs of the honeybee. (Snodgrass Fig. 29)

The LEGS of the honeybee are highly modified for several purposes besides that of walking. The front legs are modified to form the antennae cleaner which consists of a notch as shown in (A) and enlarged at (C) over which closes a specially modified spur (B). By grasping the antennae between the notch and spur the bee is able to clean this sensitive appendage of any pollen or dust that may adhere to it.* The MIDDLE legs have no special modifications of importance except that, like the other legs, they carry brushes for collecting pollen from the body and legs. The HIND legs of all three forms, the worker, the queen, and the drone have both the tibia and the large basal segment of the tarsus (1 Tarsus) much flattened. In the worker only are these segments modified into important organs.

13. (23607-B) The hind legs of the worker.

The outer surface of the tibia is fringed on each edge by a row of long, curved hairs. These constitute a sort of basket in which pollen collected from the flowers is carried to the hive. These structures are known as pollen baskets. The inner segment of the flat basal segment of the tarsus (1 Tarsus) is provided with several rows of short stiff spines forming a brush by means of which the bee scrapes the pollen from its middle legs which have combed the pollen from its body and legs that become covered with this dust from the flowers the bee visits in its search for nectar. As pollen accumulates on the brushes of the hind legs it is forced into the pollen baskets by the rubbing together of the inner surfaces of the hind legs, is patted down with the middle legs, and the worker flies back to the hive with a great mass of pollen adhering to its hind legs. The pollen baskets are also made use of for carrying propolis.

14. (23608-B) End of last tarsal joint of first foot. (Snodgrass Fig. 30)

The last tarsal joint of each leg bears a pair of claws and and empodium or adhering foot by which the bee maintains itself on a smooth slippery surface like glass where claws are of no avail.* This soft pad, the empodium, is flattened out against the smooth surface to which it adheres by the aid of a sticky liquid secretion.

15. (23609-B) Outer view of hind claw of worker, queen and drone. (Snodgrass Fig. 31)

The hind claws of drone, queen and worker differ markedly.*

THE ABDOMEN AND WAX GLANDS

16. (23610-B) Lateral view of abdomen of worker. (Snodgrass Fig. 32)

The abdomen of the bee consists, as has been said, of a number of over-lapping plates of chitin which telescope, to some degree, one within another, being connected by soft membranes which permit free movement. The upper set of plates carry the spiracles or breathing tubes. The two plates of the last segment in the worker and queen are separated by a cleft on each side and if they are spread apart it is seen that the tip of the abdomen incloses a cavity which lodges the sting and its accessory parts.*

17. (23611-B) Ventral view of abdomen of worker. (Snodgrass Fig. 33)

The last four plates (IV - VII) on the under side of the abdomen have smooth surfaces which are known as wax plates. The wax is formed by a layer of cells on the inside of these plates and accumulates in a small scale on the outside of smooth surface, being protected by the overlapping of the plate in front of it. The wax is first secreted in a liquid condition, coming out through minute pores in the wax plates, hardening on their under surfaces into the little plates with which every beekeeper is acquainted. The secretion of wax is best performed during the prime of life, which in bees is at about 17 days of age or before, while old bees only gather nectar and pollen. Bees do not normally secrete wax while performing other more ordinary duties of the hive. When comb is needed, a large number of young bees or bees that have not passed their prime hang together in vertical sheets or festoons within the hive and are fed an abundance of honey. After about 24 hours they begin to construct comb. During this time the wax is secreted through the wax plates and accumulates in the external wax pockets below. It is poked out of these pockets by means of the spines on the legs and is passed forward beneath the body to the mandibles. By means of these organs it is manipulated into little pellets and modeled into comb.

18. (23612-B) Tip of abdomen of worker with left side removed. (Snodgrass Fig. 41)

THE STING

This view shows the tip of abdomen of worker with the left side removed showing the sting and the parts connected with it. The sting which is easily protruded, receives its venom from the poison sac.*

The large POISON SAC does not of itself eject the poison from the sting, but this is done by an actual pumping apparatus operated by the same muscles that move the barbed lancets themselves.

19. (23613-B) Sting and poison glands of the queen, dorsal view. (Snodgrass Fig. 57)

The sting of the queen is much longer than that of the worker and is more solidly attached to the sting chamber. Its lancets have fewer and smaller barbs than that of the worker but the poison glands are well developed and the poison sac is especially large.

There are four glands connected with the sting, two of which are known to secrete poison. It is supposed that the other two glands secrete a lubricating liquid, but this is not certain. The large, conspicuous poison sac contains an acid liquid supplied from two poison glands, one of which supplies an acid and the other an alkaline liquid. The two secretions, one alkaline and the other acid, are poured together into the base of the sting bulb and mix within its cavity. The liquid from either gland, by itself does not seem to have the peculiarly poisonous properties possessed by the mixture of the two liquids.*

The sting is attached by very delicate membranes to the surrounding parts and tears easily from the living worker bee as it hurriedly leaves the victim after stinging. The worker thus inflicts a wound at the cost of its own life. Nature evidently regards the loss of life of one or of a hundred bees as of little importance in the defense of the community from an enemy. The entire stinging apparatus is left sticking in the wound while the muscles, which keep on working automatically, continue to drive the sting in deeper and deeper and at the same time pump in more poison. This provision produces more effective results than would a bee giving quick thrusts and then flying away to escape danger.

20. (23614-B) Ventral view of sting of worker and acessory parts, flattened out. (Snodgrass Fig. 37)

The sting itself when extracted from its chamber, is seen to consist of a straight tapering shaft with a swollen base.* The sting shaft is not a simple structure as it appears to be, but is a hollow organ made of three pieces which surround a central canal. The dorsal piece, known as the sheath, has tracklike ridges on which the two lancets or darts slide freely.

21. (23615-B) Details of sting of worker. (Snodgrass Fig. 40)

As will be seen, the tips of the lancets are barbed and, since they often work alternately, once the tip of the sting has imbedded itself, it enters deeper and deeper into the wound as the muscles continue the movement of the lancet.* A cross section of the sting is shown at (B). The central channel is the poison channel, which it will be noted, is not entirely closed in the section (A) near the tip, thus allowing the poison to exude from the sting near its point. The two lancets may also be seen in (B and A) dovetailing with the ridges of the central shaft on which they slide.

22. (23616-B) The alimentary canal and its glands. (Snodgrass Fig. 42)

THE ALIMENTARY CANAL AND ITS GLANDS

Digestion is brought about by substances called enzymes which are contained in the various liquids mixed with the food in the alimentary canal. These liquids are secreted by the salivary glands and by the cellular walls of the stomach. The opening of the salivary duct on the base of the proboscis has been described. The true salivary glands are arranged in two pairs, one situated within the head and the other within the thorax. The four ducts unite into one tube. The other large and conspicuous pharyngeal glands lying within the upper part of the head and opening into the pharynx are supposed to secrete the brood food and royal jelly instead of a digestive liquid like saliva, but this is not definitely known. They are absent in the drone and only rudimentary in the queen.

The FOOD OF THE BEE consists normally of pollen, nectar, and honey. The first is eaten entirely with the mandibles while the other two are taken through the proboscis. Pollen is to the diet of the bee what meat is to ours; it contains the proteid or nitrogenous element, and also substances comparible with fats and carbohydrates. The nectar and honey consisting principally of sugars belong to the class of foods known as carbohydrates.

The ALIMENTARY CANAL (Esophagus to rectum) is a tube which extends through the entire length of the body. It has no openings of any sort into the body cavity. The internal organs are packed closely about it, and the interstices are filled with the blood, there being no special arteries or veins in insects. The ESOPHAGUS extends to the honey stomach. (This will be shown, enlarged, in the next slides). Then comes a large U-shaped part, the ventriculus or stomach of the bee, frequently referred to as the "chyle stomach." Following the stomach is a coiled small intestine having a circle of about 100 long, coiled, thread-like tubes opening into its front end. These are the Malpighian tubules. They are excretory organs corresponding with the kidneys of vertebrates. Following the small intestine is the large intestine or rectum, which is often distended by its contents into a great sac occupying a large part of the abdominal cavity.*

BROOD FOOD. There is not enough known about the source of the brood food to enable one to make definite statements. It is a milky-white, gummy paste with a strong acid reaction and contains principally proteids with some fat and sugar. It comes out of the mouths of the workers and is probably produced by the pharyngeal glands of the head. These glands are always largest in those individuals that feed the brood, and they reach their highest development in the workers of the honeybee. From this it would seem that they are accessory to some special function of the worker. This food is fed to the larvae by the workers and is produced in greatest abundance by the younger individuals. The larvae of the queens are said to receive nothing but this food while the larvae of drones and workers receive the pure product only during the first three days. From the fourth day on, honey is said to be mixed with the diet of drones and workers and, in the case of the drones, undigested pollen also. The adult queens and drones receive a certain amount of prepared food throughout their lives; if they do not get it they become weak. While they can feed themselves with honey they apparently cannot eat pollen and cannot get the proteid element of diet unless fed this in a predigested condition by the workers. During egg-laying the queen especially demands this food and by furnishing or withholding it the workers probably have the power of influencing her production of eggs.

The VENTRICULUS is the largest part of the alimentary canal. When examined in a freshly killed bee, it is of a dark brown color with lighter rings corresponding to the constrictions. Its contents invariably consist of a dark-brown mucilaginous slime and generally, also, of a varying amount of pollen which is always fresh-looking and does not seem to undergo any digestion until it has passed into the small intestine. The contents of the small intestine are usually drier than those of the ventriculus, consisting principally of masses of partly digested pollen.

The LARGE INTESTINE is a sac, which may be limp and flabby in the rear part of the body or it may be so distended by the amount of its solid and liquid contents as to occupy a large part of the abdominal cavity. Its recognizable contents consist mostly of empty shells of pollen grains or of shrunken grains although a few are always to be observed that are perfect and fresh looking, showing no evidence of digestion.

23. (23617-B) The honey stomach of worker, queen and drone. (Snodgrass Fig. 44)

The HONEY STOMACH is simply an enlargement of the esophagus. It is best developed in the worker but is present also in the queen and drone.* The principal function of the honey stomach is to hold the nectar as it is collected from the flowers and to allow the workers to accumulate a considerable quantity before returning to the hive. When empty it is a small flabby pouch, but when full it is an enormous balloon-shaped bag with thin, tense walls. When a worker with its honey stomach filled with nectar reaches the hive, the nectar is stored directly in a cell or is given up to some other worker who places it in a cell.

Honey, which is made from regurgitated nectar does, indeed, contain some pollen, but most of the pollen eaten by the bee is retained in the stomach as food. The wall of the honey stomach has been cut away to show the stomach-mouth which controls the admission of food into the true stomach, or ventriculus. It is not known that the worker eats pollen while she is gathering nectar and it is probable there are never more pollen grains in the nectar in the honey stomach than is found in the honey itself, so that it appears most logical to regard the stomach mouth as simply the ordinary apparatus for controlling the admission of food to the digestive stomach.

24. (23618-B) The respiratory system. (Snodgrass Fig. 50)

THE RESPIRATORY SYSTEM

That an animal may live it must have oxygen. In the bee, instead of the blood being carried to the oxygen, the oxygen is carried to the blood by tracheal sacs and a multitude of branches which go to every part of the bee's body. These small internal air-tubes are called tracheae and they open to the exterior of the body where they receive their air supply, by a number of small orifices called spiracles, situated along the sides of the thorax and abdomen. These tubes and their capillary branches, coming into close contact with the blood practically make a lung of the entire body. These tracheal tubes take up waste products, carbon dioxide gas and water, from the tissues, and it is exhaled from the spiracles or breathing apertures. Two large strong tracheal tubes extend backward from the head and thorax to the first thoracic spiracles. The body of the bee is probably more abundantly supplied with air than that of any other insect. In the head, the thorax, and the abdomen, are large tracheal sacs. These sacs are storehouses of air, not for the purpose of lightening the weight of the body but as reserve supplies of oxygen.

25. (23619-B) Longitudinal, median vertical section of entire body of worker. (Snodgrass Fig. 1)

The large size of the tracheal sacs may also be seen in this view in thorax and abdomen.

The respiratory movements of the bee vary according to its activity. While sitting quietly or walking slowly about, a bee exhibits almost no respiratory motion, only a slight trembling of the abdomen being visible. A bee that has just alighted after flying exhibits pronounced abdominal movements.

THE CIRCULATORY SYSTEM

The blood of the bee is a colorless liquid containing opaque granular cells or corpuscles floating in it, but no red ones such as are found in mammals. There are no special blood vessels, but there

are very definite channels between the muscles and viscera through which the blood flows, while membranes stretched across the walls of the abdomen inclose sinuses which play an important part in the circulation. These membranes or diaphragms rhythmically contract and, with the aid of the heart, maintain the circulation of the blood. The heart is a long narrow tube which is swollen toward the middle into a heart chamber. The heart extends from the abdomen, through the thorax, becoming a long, narrow tube which extends into the head. The blood is driven from the heart into the head where it bathes the brain and other organs of that region and then flows backward, percolating through the spaces between the organs of the thorax.*

Since bees are very active creatures they need, except under the quiescent conditions of winter, a large supply of oxygen, but as they belong to the class of animals without red blood, nature has provided them with another means of obtaining a special supply of air, namely, a set of air-tubes branching minutely over nearly all the internal organs, the tissues and even most of the cells of the body.

THE NERVOUS SYSTEM AND THE EYES

The nervous system is the source of those physical and chemical processes that constitute life and it is the seat, also of all sense perceptions and consciousness. We do not know, however, that insects possess consciousness.-- that they are actually aware of their own existence, and we therefore do not know that they have conscious sense perceptions. We do know that they are affected by external objects -- by light, heat, taste, odor, pressure, and perhaps sound, acting upon specially sensitized cells called sense organs, but we do not know that the reaction of an individual is anything more than the exhibition of a very highly developed reflex nervous system. It is probable that bees do all that they do -- make comb, store up honey and pollen, feed the young, attend to the wants of the queen, and so on -- without knowing why, and we have no evidence that they are even conscious of the fact that they do these things. No one has ever proved that insects may be possessed of even a very slight conscious intelligence.* The NERVOUS SYSTEM is comparatively simple consisting of small nerve masses called ganglia lying along the mid-lower line of the body, the ganglia being connected by a pair of nerve fibers while nerve fibers also branch to all parts of the body. They receive the stimuli from the sense organs and convey the impulses to and from the nerve centers.

26. (23620-B) Nervous system of worker - dorsal view. (Snodgrass Fig. 52)

These ganglia function to some extent even if separated from the brain. If the head is removed, the animal can still walk and if the abdomen is removed, food can still be taken. These facts indicate that the nervous control of the body is not centralized in the brain as completely as in man and many other animals.

27. (23621-B) Brain and subesophageal ganglion of the worker and their principal nerves, anterior view. (Snodgrass Fig. 53)

The brain of the bee is composed of two parts, the proto-cerebrum carrying the large optic lobes and the deuto-cerebrum, which consists principally of the antennal lobes that give off the large antennal nerves.*

The EYES of the bee are intimately connected with the nervous system, as shown. The simple eyes of the bee have never been carefully studied. The convex outer surface or cornea of the eye presents a honeycomb appearance under the microscope and each little hexagonal facet is the outer end of an eye tube all of which converge toward the inner base of the eye.

28. (23622-B) Horizontal section of compound eye and optic lobe of worker. (Snodgrass Fig. 54)

This is a horizontal section through the compound eye and the optic lobe of the brain. The thin rods or eye tubes may be seen extending from the cornea and converging on a basement membrane which is penetrated by the nerve fibers from the optic lobe. The nerve fibers convey the stimuli to the nerve cells of the brain, which are the true seat of sight perceptions, as of all other perceptions.*

There has always been discussion as to how bees see with compound eyes, but the weight of opinion favors the theory that they see a part of the object or field of vision with each facet of the eye.

29. (23623-B) Worker, queen and drone of honeybee.

THE REPRODUCTIVE SYSTEM

The reproduction organs are those that produce the cells from which new individuals are formed. All animals grow from at least one cell called the egg and almost all from a combination of the egg with another cell called the spermatozoon. The uniting of these two cells is called the fertilization of the egg. In a few animals the two different kinds of reproductive cells are formed in the same individual, but in most of them, including all insects, the sperm and the eggs are produced in different individuals -- the males and the females. In the honeybee the males are called drones, while the females are called queens or workers, according to their function in the hive. The queens have the ovaries or egg producing organs greatly developed, while these organs are rudimentary in the workers. The single active queen in each hive produces all the eggs of the colony, while the work of rearing and providing for the brood falls to the lot of the workers.

In some of the higher wasps there is a beginning of that specialization which is carried to perfection in the honeybee. Some of the first female wasps hatched in the spring are sterile and help

prepare for a larger family by enlarging the house and providing food. In the honeybee, one form of the female is specialized entirely to produce the young and the other to rear the brood, keep the home in order, gather food, and ward off enemies. The differences between the queens and the workers seem to result from the different diet on which larvae designed to be queens are brought up. The work of numerous investigators seems to have demonstrated clearly that the drone of the honeybee is always produced from an egg cell alone -- that is, from an unfertilized egg -- while the queens and workers are produced from fertilized eggs. The production of eggs that develop normally without the addition of the male element is called parthenogenesis. As far as is known the production of males alone from parthenogenetic eggs is confined to the order of Hymenoptera, to which bees belong.

30. (23624-B) The reproductive organs of the drone. (Snodgrass Fig. 56)

The REPRODUCTIVE ORGANS of the DRONE are shown by (A). They consist of the testes, the vasa deferentia, the vesicula seminales, the accessory or mucous glands, the ductus ejaculatorius, and the penis.

In the mature drone, these elongate sacs, the vesicula seminalis, are densely packed with active spermatozoa, while the testes that produced them become rudimentary. The accessory mucous glands, two large sacs, are filled with a thick, white, liquid which forces the spermatozoa forward during mating. These two glands open at their bases into the single duct which opens into the penis. This last organ, shown here (E) in lateral view, is turned within itself while within the body of the drone. In the act of copulation it is turned inside out into the oviduct of the queen, its basal pouches (zzA and E) being forced into corresponding pouches of the oviduct. The spermatozoa in the bulb (E) being placed near the spermatheca of the queen, it is probable that the spermatozoa make their way up into this receptacle where they remain until ejected upon eggs passing down the oviduct.* The spermatozoa received from one drone normally last the queen throughout her life, so that after mating she goes into the hive never to emerge again except with the swarm, and her entire life is devoted to egg laying. The drone, on the other hand, dies immediately after mating, while those drones that do not mate are driven out of the hive in the fall and left to starve.

31. (23625-B) The reproductive organs of the queen. (Snodgrass Fig. 57)

THE FEMALE ORGANS. The organs of the female that produce the eggs are called the ovaries. An egg is simply a very large cell whose size is due to the great accumulation of yolk which serves as food for the future embryo. The two oviducts converge and unite into a common duct the vagina. There is also present the spermatheca, a receptacle for the spermatozoa, which opens directly into the vagina.*

Since the queen lays continuously during her entire life the ovaries always contain eggs in all stages of growth. She must also be able to dole out the spermatozoa to the eggs as she deposits them and although this is accomplished by means of the spermatheca and an intricate muscular apparatus of its duct for delivering the spermatozoa to the egg it does not throw any light on the DETERMINATION OF SEX IN BEES. Each unlaid egg has a small hole in the upper end of its shell, called the micropyle, which admit the spermatozoa to its interior. One or several spermatozoa may enter through this aperture, but the nuclear part of only one unites with the egg nucleus, this constituting the fertilization of the egg. After this the micropyle closes and the egg is deposited in a cell of the comb by the queen.

UNITED STATES DEPARTMENT OF AGRICULTURE
EXTENSION SERVICE, C.W. WARBURTON, DIRECTOR—OFFICE OF COOPERATIVE EXTENSION WORK, C.B. SMITH, CHIEF

LANTERN SLIDE — TRANSFERRING BEES TO MODERN HIVES — SERIES 167

This series of 49 slides, supplementing Farmers' Bulletin 961, "Transferring Bees to Modern Hives," and illustrating practical methods of transferring bees from box hives and log "gums" into movable-frame hives, is prepared from illustrations selected and arranged in cooperation with the Bureau of Entomology. Supplementary notes prepared by the Bureau of Entomology for use in presenting the subject are attached. This series is available for loan from the Office of Cooperative Extension Work, Extension Service, United States Department of Agriculture.

Slide number	Negative number	Legend
1	28691-B	Title slide.
2	28650-C	Credit slide.
3	8126-A	An apiary of box hives.
4	28404-B	Cutting combs from a box hive.
5	28740-C	A demonstration in transferring bees. Colony inclosed in a sack of coarse texture.
6	5834	Two box hives from which contents are to be transferred.
7	5836	Preparing to transfer bees.
8	5837	Drumming bees from a box hive.
9	5835	Bees partly drummed out of the box hive.
10	5838	Brushing bees off the box hive.
11	23623-B	Worker, queen, and drone of honeybee.
12	5839	Box hive open.

IMPORTANT: This lantern-slide series is available for loan both on film strip and on glass slides.

DISTRIBUTION: A copy of this syllabus has been sent to each State extension director, extension editor, and specialist in visual instruction and in apiculture.

Revised 9 - 1 - 30.

Slide number	Negative number	Legend
13	5840	Fitting comb into a Langstroth frame; marking comb for cutting.
14	5841	Comb tied in a Langstroth frame.
15	1664	A comb not fit for brood rearing.
16	5842	A frame filled with foundation.
17	1760	Embedding wire in foundation.
18	1666	Comb built from foundation.
19	5843	Transferring completed by this method.
20	21659-B	An apiary of log "gums" before transferring.
21	21657-B	The same apiary after transferring.
22	21655-B	Log "gum" colony before transferring.
23	21654-B	Log "gum" colony after transferring.
24	Apic. No. 5644	Exhibit of 278 pounds of honey produced by this colony the same season it was transferred.
25	8099-A	Row of straw skeps and "gums" under shelter.
26	Apic. No. 635	Old and new hives side by side.
27	8121-A	Old box hive set on top of new hive with queen excluder between.
28	28739-C	Queen excluder.
29	28619-B	Transferring bees by setting new hive on top of box.
30	Apic. No. 1468	Group of modern hives, each with several supers.
31	8100	Log "gums" with doors cut for removing honey.
32	14778-B	Apiary of box hives in which transferring has begun.
33	8134-A	Nailing on cleats to support hive body.
34	8135-A	Placing new hive on inverted box hive.

Slide number	Negative number	Legend
35	8123-A	Driving bees up into new hive by means of smoke and drumming.
36	8133-A	Drumming bees into new hives.
37	8119-A	Lifting new hive off box hive, showing bees on frames.
38	8136-A	Shaking bees out of box hive in front of new hive.
39	8118-A	New hive with fine swarm of bees that was drummed out of the log "gum."
40	Apic. No. 327	Log "gums" with comb built below.
41	Apic. No. 439	Apiary of plank "gums."
42	28620-B	A 10-frame hive with comb-honey super and perforated-zinc queen excluder arranged to show each part.
43	28618-B	View of modern hive for extracting.
44	28741-C	Bee-escape board for removing bees from supers.
45	Apic. No. 169	An outdoor colony - combs attached to the limb of a tree.
46	Apic. No. 18813-B	A modern apiary.
47	Apic. No. 1050	Apiary sheltered from the wind.
48	36998-B	Cover of Farmers' Bulletin 961, "Transferring Bees to Modern Hives."
49		United States Department of Agriculture lantern-slide and film-strip service.

Supplementary notes for Lantern-Slide Series 167

TRANSFERRING BEES TO MODERN HIVES

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Slide number and legend

Hundreds of thousands of colonies of bees, about one-third of the bees kept in the United States, are housed in log "gums" and in box hives. They produce an insignificant amount of honey compared with what they might be made to produce if they were transferred to movable-frame hives and handled by modern methods. Much of the honey produced by colonies in box hives is wasted by crude methods of obtaining the crop and lack of swarm control. The care that is essential to the production of large crops of honey can be given only to those bees which are in movable-frame hives. Hence all bees in box hives and log "gums" should be transferred at the proper season, and the beekeeper should make a study of the best methods of beekeeping. If all beekeepers now keeping bees in box hives would do this, they would not only gain more profit from their bees but they would add many million pounds to the honey supply of the country.

Bees are wild animals, and man can handle them only in accordance with their natural activities if he wishes them to yield the best return. The man who understands bee behavior can do almost anything with bees if he does not try to make them do anything which is contrary to their nature. If one does not intend to study his bees and to give them proper care, the modern movable-frame hive is no better than the box hive. To make the business successful, one must study the best methods of modern beekeeping. One needs to become familiar with the bee colony, to study the arrangement of combs and brood nest, and to learn of the queen and her work. The old method of transferring gives an excellent opportunity to obtain first-hand information regarding the natural activities of bees.

Beekeeping is applied bee behavior, and success depends upon a study of the life history and habits of the honeybee.

Slide number and legend

Too many beekeepers work by rule of thumb, but the successful beekeeper is a student of bees, adapting his practice to changing seasons and knowing what to expect of his bees under given conditions.

Transferring, as the word is used by beekeepers, means the removal of a colony of bees, either with or without its comb, from its home in a box hive or "gum" into a modern movable-frame hive. There is scarcely any work connected with beekeeping which involves such intimate contact with the bee colony, its habits of work and its behavior, as does transferring by the old method, in which the combs are cut from the old hive, one by one, with all the bees adhering to the combs, the bees shaken off, and the combs fitted into the movable frames of the new hive. If the beginner can successfully transfer a colony from a box hive in this way, he is on the road to become a beekeeper.

Transferring is frequently done, especially by the old method, during fruit bloom, when the combs contain little honey and when the bees will gather nectar rather than rob. Another good time for transferring is immediately after the casting of a swarm, when the number of bees in the hive is greatly reduced and there is no danger of losing the queen. Transferring can be done, however, at any time when some nectar is coming in, although during a honey flow the combs will be heavy and difficult to handle. It can also be done at any time in the active season if care is taken to see that the bees do not suffer from lack of stores. It may be necessary, also, to supply them with winter stores if transferring is done late in the season. It is usually well to transfer the first few colonies late in the afternoon so that robbing, if it does begin, will stop with night.

3
An apiary of box hives

(Slide 3.) Apiaries such as these are common in the more mountainous districts of the Southern States. Many of them are being transformed by transferring and the use of modern beekeeping methods.

Transferring bees by the old method gives the novice in beekeeping an excellent opportunity to obtain useful and necessary information about beekeeping activities.

Shorter and easier methods of transferring have been devised, but the old method is still a useful one.

4
Cutting combs from a box hive

(Slide 4.) By the old method of transferring, the combs are cut out one by one and fitted into the frames of the new hive. The bees may all be allowed to remain

Slide number and legend

on the combs until these are cut from the hive, then the bees may be shaken or brushed into the new hive, and the combs fitted into the frames.

It is better, however, first to drive most of the bees from the box hive into an empty box by drumming, which will be shown in a later picture, and to brush or shake the removed bees in front of the new hive as in hiving a swarm. In this way there is less danger of killing the queen and less bother from bees adhering to the combs.

5 Colony brought from a distance

(Slide 5.) If a colony is to be brought from a considerable distance to the place where it is to be transferred it may be inclosed in a sack of coarse texture through which the bees may obtain air.

3 Two box hives which are to be transferred

(Slide 3.) Before the work is begun, the operator should have ready the necessary tools and equipment, so that he may do the transferring quickly and not be compelled to stop work to get some forgotten necessity. A basin or pail of water is necessary, as the operator should wash the tools and his hands frequently enough to keep them free from honey.

7 Preparing to transfer bees.

(Slide 7.) The new hive must, of course, be ready and the comb held in place entirely by strings, or wires may be bent so as to snap over the top and bottom of the frames to hold the combs in place. A saw, hammer, cold chisel, and perhaps an axe will be needed for opening the old hive. A ball of soft wrapping twine and a heavy butcher knife should be provided, as well as two clubs or sticks for drumming on the box hive. A small box with an opening about the size of the box hive, or a little larger, is needed into which to drum the bees, and a large board or hive cover on which to cut and fit combs should be provided.

On a fine day when many of the bees are out gathering honey, a little smoke should be blown into the entrance of the box hive to induce the bees to fill themselves with honey. The box hive should be removed from the old stand and set a little distance away; then the new hive, preferably with at least one drawn comb in it, should be placed on the old stand to receive the returning bees. A little more smoke should be blown into the entrance, the box hive should be inverted, and the bottom, if there is one, should be removed.

8
Drumming bees from box hive

(Slide 8.) The box hive is then placed as shown, with its bottom edge in contact with the new hive so that the bees will have a good runway from the old hive to the new one. Usually there is a hole in the top of the box hive into which some smoke may be blown to help start the bees running into the new hive, or, if there is no hole, the top of the hive may be pried open enough to admit some smoke.

9
Bees partly drummed out of the hive

Heavy sticks or hammers are used to rap on the sides of the box hive hard enough to jar the combs but not to loosen them. The strokes should be regular and continuous. After a few raps and some smoke, the bees will begin to run; and the drumming should be continued 10 or 15 minutes, until three-fourths or more of the bees have left the box hive and run into the new one or (Slide 9) clustered outside, as shown in this picture.

10
Brushing bees off the box hive

When most of the bees have left the box hive, the bees which have clustered on the outside of the hive may be brushed (Slide 10) off in front of the new hive. Many of them will run into the hive, especially if a comb or two from some other colony has been placed in the new hive. A little shaking and jarring will dislodge more bees, although the jarring should not be sufficient to break the combs from the hive walls. Care should be taken, also, not to kill bees at this time, as the queen will be somewhere in the mass of bees and to kill her might mean the loss of the colony.

11
Worker, queen, and drone of honeybee

(Slide 11.) If the queen is not seen as the bees pass into the hive it will be well to drum more bees from the box hive to avoid losing the queen while cutting out and fitting the combs. As will be seen from the illustration, the queen is easily distinguished from the worker by her size and from the drone by her slender long body in comparison with the heavier, square-bodied drone. If the beekeeper has several drawn combs, he may put them into the new hive, and, with the two hives placed in the positions shown, with a clear runway between, the bees may be drummed directly into the new hive.

12
Box hive open-combs exposed

(Slide 12.) After the drumming is done, the box hive is split or pried open to expose the combs, and these are cut out one by one. The bees remaining on the combs are brushed off into the new hive. As soon as possible, a frame should be filled with the comb containing brood and put into the new hive unless drawn combs have already been given.

13
Fitting comb into a Langstroth frame-marking comb for cutting

(Slide 13.) To fit comb into a frame, a large piece of comb is laid flat on the cutting board or on sheets of heavy paper, and the frame is placed loosely on top. The outline of the inside of the frame is marked on the comb with the point of a knife and, after the frame is set aside, the comb is cut to fit tightly in the frame. Particularly if a colony from a round gum is being transferred, it may be necessary to fit two or more pieces containing brood into one frame, but it is not wise to save small pieces of comb or drone comb. The comb should fit into the frame snugly so that it will be held closely until fastened by the bees.

14
Comb tied in a Langstroth frame

(Slide 14.) After the frame is fitted around the comb as it lies on the board, both comb and board are raised to an upright position. The board is now laid aside; the cord is fastened by wrapping it once or twice around the projecting lug of the top bar. It should then be wrapped several times around the frame, using cord enough to bind the comb securely in the frame. The cord is tied or is fastened by again wrapping it tightly two or three times around the lug of the top bar. If preferred, short strings may be used, these being laid on the cutting board while combs are being fitted into a frame and then tied tightly before the frame is raised from the board. Gummed paper tape may also be used for fastening the combs into the frames.

15
A comb not fit for brood rearing

As fast as frames are filled they should be placed in the hive. (Slide 15.) This is a specimen of a poor, crooked comb, one which has been rendered almost useless by the sagging of the foundation and the buckling of the comb. It illustrates well the result of having poor comb in the hive. The few available worker cells in the comb are filled with brood, yet only a small part of the comb space is occupied. The remainder of the comb contains drone cells or is so sagged and crooked as not to be fit for brood rearing. When transferring, no drone comb should be saved, and it is usually best not to save any worker comb unless it contains brood. If any empty comb is saved, only large, regular pieces should be selected.

16
A frame filled with foundation

(Slide 16.) Enough combs filled with honey must be saved to meet the immediate needs of the colony. The bees themselves will remove the soft twine used in transferring, but strips of wood should be removed after a week or 10 days. Frames not filled with comb should be filled with full sheets of foundation, of which several types are on the market.

Slide number and legend

17
Embedding wire in foundation

(Slide 17.) The frames should be wired to help support the sheets of foundation, and a small, toothed wheel is used to embed the wires in the sheets of wax. The wires may also be embedded by heating them with electricity, which gives much better results.

18
Comb built from foundation

Here (Slide 18) is shown a comb built from foundation as it appeared three weeks after transferring, when filled with worker brood. This illustrates the value of good combs in which the colony can rear many thousands more young bees than it could in imperfect, crooked combs, as shown in a previous picture.

19
Transferring by this method completed

(Slide 19.) The new hive is closed and the old hive and all the waste comb have been taken away. Any honey that has been spilled has been washed up and all has been made clean, to avoid starting robbing. This colony in the new hive now is ready to build up into a profitable honey-producing colony, similar to the one standing behind the other box hive which still remains to be transferred. Instead of splitting up the box or log "gum," the cross sticks may be sawed off and the combs cut loose from the sides of the hive with a saw; or, in a round "gum," this may be done with a long knife, the top of the hive being pried loose as the box hive rests, inverted, on the ground. The entire box or round "gum" should be lifted off, leaving the mass of combs exposed and ready to be fitted into frames. When following this method care should be taken in warm weather that the combs do not collapse from their own weight. The mass of comb in a box hive or "gum" may, however, be so crooked and irregular as to be almost useless for transferring; nevertheless one or two good combs may perhaps be saved, the rest of the frames being filled with full sheets of foundation.

Any bees remaining on parts of the old hive should be brushed off into the new hive, and all scraps of comb and wax should be placed in a closed box to be melted up later. Everything should be washed clean to prevent robbing.

If the combs have been cut without splitting up the round "gum" or the box hive, the bees remaining in the hive may be shaken in front of the new hive by jarring one corner or edge of the "gum" on the ground. Then they will quickly enter the hive. Any good honey may be saved for home use, or may be put in a pan and fed back to the bees by placing it in an empty upper story over

Slide number and legend

the brood combs. In all this work great care should be taken that bees from other hives do not come to help themselves to honey, or serious robbing may be started. If robbing begins, everything should at once be taken inside a bee-tight house and the transferring should be finished there. All work with bees should then be stopped for the day. If transferring is to be done when robbing is likely, the work may be done under a tent of cheesecloth which is set up over a grape arbor or some convenient frame.

20
An apiary of 123 log "gums" before transferring

The bees in the new hive will immediately set to work to fasten the combs into the frames and to repair all damages. In a few days two experienced men will be able (by transferring) to transform (Slide 20) such an apiary as this one, of 123 log "gums," into a modern apiary in movable-frame hives.

21
The same apiary after transferring

This is a view (Slide 21) of the same apiary later in the season after transferring and after the honey flow has begun. The brood nest having been filled, many of the colonies have been given a second story of combs or of comb foundation. Some good kindling wood and a pile of old boxes or of log "gums" and a lot of old comb to be melted into wax are all that remain of the old apiary. The bees are in the new hives ready to go to work storing honey in the conveniently arranged homes provided for them.

22
Log "gum" colony before transferring

(Slide 22.) As an example of the results often obtained after transferring, you will be interested in this "gum" from the apiary which you have just seen.

23
Log "gum" colony after transferring

The colony which was in this "gum" was transferred into (Slide 23) a new hive where it built up into a strong colony and filled the upper stories shown in this picture.

Two hundred and seventy-eight pounds of honey were taken from this colony the same season it was transferred, and enough was left with the bees for their winter stores.

24
Exhibit of 278 pounds of honey produced by this colony the same season it was transferred

This exhibit (Slide 24) of 278 pounds of honey produced by this one colony transferred from a log "gum" to a modern hive is proof that good beekeeping pays well. Although this is a large yield, 60 to 180 pounds per colony is a frequent result of transferring operations. In one case 2 transferred colonies produced 240 pounds surplus, which sold for $60. The remaining 10 colonies, not transferred, produced no surplus. Of course, all the colonies were transferred the next spring. Another man produced 180 pounds from his best transferred colony,

Slide number and legend

which he sold for $45. Crops such as these, the result of a demonstration in transferring, frequently revolutionize the beekeeping of a whole neighborhood, since the possibility of manipulation in the movable-frame hives makes easy the introduction of queen bees of better stock, the cleaning up of disease, and the use of comb foundation, which results in good combs and strong colonies capable of storing good crops of honey.

Many other methods of transferring are useful in particular instances, and some of them require comparatively little work, although the time required to complete the transfer is usually longer. One method is the drumming out of bees and hiving them on full sheets of foundation. This method is of use in cases where the hive is difficult to open or where one finds hives of too much interest to destroy, as in this one (Slide 25), showing several straw skeps and log "gums" under a shed, or this (Slide 26), where the bees are in their original home in a branch of a tree, with a box on top for surplus honey. When drumming out the bees and hiving on full sheets of foundation, the box hive or "gum" is set a few feet to one side, not close to the new hive, as this picture shows, and a hive with movable frames containing drawn combs or full sheets of foundation is put exactly in its place, so that as the field bees return they go at once into the new hive. It is well to put into the new hive a frame containing some eggs and young larvae from which the bees may rear a queen in case the old queen has been lost. The box hive is turned upside down, and three-fourths or more of the bees are drummed out, as shown in a previous picture, into a box a foot or so square placed on top of the inverted box hive. The success of this plan depends on getting the queen out of the old hive and into the new. The box hive containing the brood and enough bees to care for it is then placed right side up in a new location, preferably a few feet to the rear of the old stand, with the entrance turned in the opposite direction. In 21 days all the worker brood will have emerged. These bees may then be drummed out and united with their former hive mates by allowing them to run in at the entrance of the new hive; or, if desired, they may be used for starting a new colony. The comb may then be cut out of the old hive and any honey saved.

25
Row of straw skeps and "gums" under shelter

26
Old and new hives side by side

27
Old box hives set on top of new hives with queen excluder between

(Slide 27.) There are many variations of the method of transferring just described. After the bees have been drummed out and hived in the new hive, the old box or the "gum" may be set on top of the new hive, with a queen excluder between. This method keeps the colony together all the time, and at any time after three weeks, when all

Slide number and legend

the brood in the box hive has emerged, it may be set off, and the bees smoked and drummed out. The queen excluder (Slide 28) may be of perforated zinc, as shown in this picture, or may be composed of a series of parallel wires placed at such a distance apart that the queen can not pass, while worker bees can go through easily. The purpose of the queen excluder in transferring is to prevent the queen from returning to the old hive once she has gone into the new hive, as she is expected to do in the method illustrated by the following picture.

28
Queen excluder-drawing

29
Transferring bees by setting new hive on top of box

(Slide 29.) This method is often used where much transferring must be done with a minimum of work. The box hive is placed with its largest surface uppermost, usually on its side, and with the combs on edge, so they will not break down. The bees in the hive should be well smoked, and the hive should not be moved to another location. What is now the top of the hive should be removed by splitting it into strips about 2 inches wide, and these strips should be removed carefully to avoid mutilating the comb. The prepared hive containing combs or comb foundation is then fitted on top of the box hive over the greatest cluster of bees, pieces of board being used to close up any remaining open spaces. The side formerly used as the bottom of the hive is now left open, and this causes the bees to work up into the new hive much sooner. If the bees are likely to rob, a board may be set up, partly to close the front of the hive. If there is some honey in the box hive, the bees will remove it if the cover is pried off, little by little, several times during the season, until finally it can be removed completely, leaving both ends of the hive open. By this time the bees will have moved all the honey into the new hive, the queen will have established her broodnest there, and the bees will have transferred themselves. As soon as the queen has begun to lay in the new hive, a queen excluder, as shown in the previous picture, may be placed between the new and the old hives so that the queen can not return to the old hive. Supers may be added on top of the new hive as needed, until at the end of the season the new hive will look like this (Slide 30), with several supers of honey ready to extract. This is a very useful plan, and usually prevents swarming for the season and enables the bees to store a full crop of honey, leaving, after the new hive has been set off on the regular bottom board, only an old box which will make good kindling wood after the old combs have been cut out for wax.

30
Group of modern hives, each with several supers

31
Log "gums" with door for removing honey

(Slide 31.) Much inventive genius has been applied to log "gums," as in this apiary, where doors have been cut so that honey may be removed without injury to the colony.

Slide number and legend	
32 Apiary of box hives in which transferring has begun	(Slide 32.) Although a box-hive apiary may be picturesque in appearance, it is not satisfactory for commercial honey production; therefore, in regions where box hives are plentiful, the extension workers in apiculture devote much of their time to demonstrations in transferring. One of these workers has developed a system of transferring which has some excellent features, and it is illustrated in the pictures immediately following.
33 Nailing on cleats to support hive body	(Slide 33.) Cleats are nailed on two sides of the box hive, level with the bottom of the hive. When the box hive is turned upside down, these cleats serve to support the modern hive body, which is usually larger than the box hive.
34 Placing new hive on inverted box hive	(Slide 34.) The box hive is here shown turned upside down; while the new hive body, containing one frame of brood and nine frames wired and filled with full sheets of foundation, is placed directly over the open end of the box hive, being supported by the two cleats and covered with the inner cover of the new hive.
35 Driving bees up into new hive by means of smoke and drumming	(Slide 35.) This is followed by smoking and drumming.
36 Drumming bees into new hives	(Slide 36.) When much transferring is to be done, several men may work at drumming. By the use of smoke blown into crevices around the box hive and by drumming on its sides, the bees are caused to go up into the new hive which has been made ready for them.
37 Lifting new hive off box hive, showing bees on frames	(Slide 37.) The new hive may be partially lifted from time to time to see what progress has been made with the drumming; and when as many bees as practicable seem to have gone up into the new hive, it may be lifted off and placed on the bottom board on its old stand. In this picture may also be seen a log "gum" wrapped up in burlap. This "gum" has been brought from a distance to be transferred.
38 Shaking bees out of box hive in front of new hive	(Slide 38.) What few bees remain in the old hive are now jounced out in front of the new hive. The box hive without bees is then carried away for removal of the brood and honey. The same process is used in transferring from round "gums." These log "gums" are usually large enough to support the new hive without having cleats nailed on.
39 New hive with fine swarm of bees that was drummed out of the log "gum"	(Slide 39.) A fine swarm of bees has been drummed out of this log "gum." A colony like this transferred in the beginning of a honey flow should give a good account of itself. The brood, after being transferred from a log "gum," may be used to strengthen the old colony or may be given to any colony needing it.

Slide number and legend

40
Log "gums" with comb built below

(Slide 40.) That much honey is lost through the use of "gums" or of small box hives in which there is not sufficient room to store surplus honey is shown in this picture. The bees have built comb and stored honey under the bottom-board of the log "gum." The owner of these "gums" said that it did not pay to keep bees. Box hives, also, are too small for a good colony of bees, and combs are frequently built outside them, as shown in this picture. When you remember that perhaps one-third of the bees in some States are kept in box hives and in "gums" in apiaries (Slide 41) such as this one, and that often it is not possible for the bees to build any comb outside the hive, you can form some idea of the loss of honey. The bees have not room enough to store it, and there is excessive swarming. Swarming can not be controlled with small hives as well as it can in those which enable the beekeeper to give the bees as much room as is needed and to supply the best methods of modern beekeeping.

41
Apiary of plank "gums"

42
A 10-frame hive with comb-honey super and perforated-zinc queen excluder arranged to show each part

(Slide 42.) The various parts of this modern 10-frame hive are separated so that they may be seen plainly. When comb honey is to be produced, supers of sections are tiered up on the hive as needed, and the supers can be arranged as desired on the hive, keeping the unfinished sections nearest to the brood nest, which aids greatly in the control of swarming, as described in Farmers' Bulletin 1198. The varying arrangements of supers are shown in this bulletin from the time the first super of sections is placed on the hive until the sealed honey is ready for removal. Swarming, which is the greatest problem of the comb-honey producer, can not be controlled successfully without the use of modern hives and plenty of supers properly used.

43
View of modern hive for extracting

(Slide 43.) Only with a modern hive with movable frames, capable of being enlarged to suit the needs of the bees, can a beekeeper obtain the largest crops of honey and handle his bees with the minimum of effort. In such a hive as this any frame may be removed at will. Combs which contain much drone comb may be removed and replaced with frames containing full sheets of comb foundation. The condition of the colony may be readily seen at any time. Super after super of empty combs or of foundation may be placed on the colony as honey is stored, thus giving room for the storing of the immense crops of honey sometimes obtained. When extracting is to be done, the combs may be removed just as readily, a whole super of combs being taken off at one time by use of the bee

Slide number and legend

escape, which lets the bees go below into the brood chamber, but does not permit their return into the super.

44
Bee-escape board for removing bees from super

(Slide 44.) The super of honey freed from bees is taken into the honey house, where it can be extracted at the beekeeper's convenience, and the combs returned to the bees for refilling.

Bees may be transferred from the walls of a house or from a bee tree by adapting the methods of transferring to the conditions involved. If the bee tree is cut down the shock of the fall may so disorganize the colony that it will offer little resistance, and the transferring may be done easily by cutting out the combs and fitting them into the frames. Any bees remaining in the cavity may be scooped out with a cup or with the hands, and dropped into or in front of the new hive.

45
An outdoor colony--combs attached to the limb of a tree

Sometimes a colony will be found in the open (Slide 45), perhaps in the branches of a tree, and it can then be transferred readily, provided the branches can be cut off and the entire mass lowered to the ground. In this picture the colony has been placed in the branches of a tree, where it could be photographed and the work of the colony observed. It is an easy task to transfer such a colony. During warm summer weather such a colony builds comb, stores and seals honey, and carries on all the processes of the colony just as it would in a hive. However, before cold weather, the colony should be transferred to a hive where it may winter safely. One by one the delicate pieces of white comb full of honey are cut away and the bees brushed into the new hive until the darker combs containing the brood are exposed. These are fitted into the frames, as already shown, and placed in the new hive, which should be supported on a temporary platform as near as possible to the colony being transferred. This new colony, or any colony transferred late in the season, will need to be fed or supplied with additional combs of honey from some other colony, if it has not had time to fill up its new hive for the winter. After all this has been done it yet remains to give the colony winter protection, which is discussed in some of the Farmers' Bulletins on bees. For best results some winter protection such as the use of windbreaks is necessary, even in the South where winter temperatures are not considered severe. Strong colonies that have wintered well have, on the average, by the beginning of the honey flow, sufficient brood to fill 12 Langstroth frames, and are the ones that make big yields of honey and put money into the pockets of the beekeepers.

Slide number and legend

46
A modern apiary

(Slide 46.) In this modern apiary, which is shown immediately preceding the honey flow, another essential for procuring a large crop of honey is well illustrated, that is, a plentiful supply of comb and supers.

The hives at the beginning of the honey flow have two stories full of brood and bees all ready for the surplus supers. These are to be seen in the background, stacked up in piles ready to be put on rapidly as more room is needed. Sufficient supers of empty combs for storing and evaporating all the nectar the bees can gather are essential for the production of a full crop of honey.

For best results in modern beekeeping, good wintering is also essential. This requires not only a good queen, plenty of young bees in the fall and abundance of good stores, but it is of the greatest importance that the apiary be located where it is protected from wind in winter. (Slide 47.) This apiary is well protected by a natural windbreak of trees and shrubs. An adjacent hill also gives good protection. Some small shrubs and trees are distributed through this apiary, serving the bees as markers for their hives and preventing the loss of young queens, which often occurs when hives are placed regularly in rows in an open field.

47
Apiary sheltered from the wind

With good wintering, resulting in strong colonies early in the spring, and with plenty of room in the hives all through the season, the beekeeper who transfers his bees to modern movable-frame hives and who controls swarming may reasonably expect to have success in beekeeping.

48
Cover page of Farmers' Bulletin 961, "Transferring Bees to Modern Hives"

(Slide 48.)

49

United States Department of Agriculture lantern-slide and film-strip service. (Slide 49.)

UNITED STATES DEPARTMENT OF AGRICULTURE
EXTENSION SERVICE, C.W. WARBURTON, DIRECTOR—OFFICE OF COOPERATIVE EXTENSION WORK, C.B. SMITH, CHIEF

Lecture Notes for Lantern-Slide Series 171

DIAGNOSIS OF BEE DISEASES IN THE APIARY

Prepared by
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* * *

This series of 58 slides, illustrating the symptoms of the different diseases of bees distinguishable in the apiary and methods of control, was prepared by the Bureau of Entomology in cooperation with the Extension Service. The series is intended for use by extension workers, State apiary inspectors, and instructors in apiculture. Workers thoroughly familiar with bee diseases can substitute their own notes for those following and still use the slides to advantage.

Slide 1. Title.

Slide 2. Credit statement.

Slide 3. Credit statement.

Slide 4. Photograph: *Examining samples at the bee-culture laboratory. It usually is possible to make correct diagnosis of bee diseases in the apiary when the symptoms are thoroughly understood. At times, however, the symptoms overlap, making laboratory diagnosis essential. Samples of brood or of bees mailed to the Division of Bee Culture Investigations, Bureau of Entomology, United States Department of Agriculture, will be examined free of charge.

Slide 5. Photograph: *Healthy brood. In a healthy colony containing a normal queen, brood of different ages is arranged with considerable regularity in a concentric manner. The cappings over healthy brood are convex, entire, and all of about the same color.

Slide 6. Reader: American foulbrood. The following slides (7 to 22, inclusive) illustrate the diagnosis and control of American foulbrood, the most destructive of the brood diseases.

Slide 7. Photograph: *An infected comb. The brood in a colony infected with American foulbrood is more or less irregular. In the early stages of the disease occasional or isolated cappings are discolored, sunken, or perforated. In an advanced case, such as is shown here, irregularity of brood is

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*Note. Legends preceded by an asterisk will appear on the screen.
IMPORTANT: This lantern-slide series is available for loan on film strip and on glass slides.

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very pronounced. It is very important for beekeepers to recognize American foulbrood, since delay in eliminating the source of infection is likely to result in widespread dissemination of the disease.

Slide 8. Photograph: *Scales in brood comb. Death from American foulbrood practically always occurs after the cells are sealed and the larvae are fully extended and motionless. Rarely do larvae die while coiled in open cells. Newly formed pupae are occasionally killed, and at times the tongues and mouth parts of pupal remains adhere to the roof of the cell. After these remains have dried and scales are formed, the threadlike tongue extends from the floor to the roof of the cell. A symptom of great importance is the pronounced uniformity of the tightly adhering, fully extended dried remains, or scales. To see the scales clearly, combs must be held so that the light comes from over the shoulder and the line of sight falls on the lower side and the bottom of the cells.

Slide 9. Photograph: *Combs cut to show scales. American foulbrood scales are of nearly the same color as are old brood combs, and in combs of this sort scales do not show distinctly. In new combs scales are readily distinguishable. American foulbrood scales extend from near the mouth of the cells to the bottom, and almost always the rear extremity is curved upward on the bottom. The surface is slightly rough, occasionally containing small, hard nodules about half the size of a pinhead, and the edges are usually wavy or irregular.

Slide 10. Photograph: *Ropy remains. The consistency of American foulbrood remains changes constantly during decay and drying. At first the remains are soft, but after about 3 weeks they become gluelike or ropy and can be drawn out into threads an inch or more long. In the early stages of decay these threads are comparatively thick and light brown, but later they are fine and dark brown. Thoroughly dry remains are tough or brittle, and are known as scales.

Ropiness is perhaps the most reliable symptom in the diagnosis of American foulbrood in the apiary, but it should be remembered that ropiness occasionally occurs in other brood diseases. In parafoulbrood, and less frequently in European foulbrood, a ropiness develops in the partially decayed remains which is difficult to distinguish from that caused by American foulbrood. The odor of American foulbrood is quite different from the odor of other brood diseases and also is a reliable symptom in identifying the disease.

Slide 11. Photograph: *1, Healthy larva; 2 to 6, stages in decay. After death from American foulbrood the glistening white of the healthy larva (1) soon changes to dull or grayish white (2). After about a week a light-brown color develops, which deepens and finally becomes dark brown (3 to 6). As decay continues the head of the dead larva settles gradually until it becomes an indistinguishable part of the scale.

Slide 12. Photograph: *1, Healthy larva; 2 to 6, stages in decay. A healthy larva (1) is plump, and the segmental markings are clearly shown. American foulbrood larvae (2 to 6) become soft and flatten out during decay, and become scales after about a month.

Slide 13. Photograph: *1, Healthy pupa; 2 to 6, stages in decay. Pupae die of American foulbrood while the body is white, although the eyes may be colored (1). The changes during decay are practically the same as those

occurring in larvae (2 to 6). Soon after death the glistening white changes to dull white, and a dark-brown color finally develops. Dead pupae soon lose their plumpness, gradually settle against the floor of the cell, and form scales. The body divisions in the scales are roughly distinguishable and the tongue may protrude or adhere to the roof of the cell. This condition is commonly spoken of as "stuck-up tongues." It does not occur in larval remains and is rarely seen in pupae dead of other causes. It is a reliable symptom but not an infallible one.

Slide 14. Photograph: *1 to 3, Discoloration of cappings; 4 to 6, removal of cappings. Death from American foulbrood practically always occurs after the cells are sealed. Brood cappings appear normal for a week or more, but in 2 or 3 weeks they may become darkened and sunken (1 to 3). In advanced cases many cappings are perforated and partially or entirely removed by the bees (4 to 6).

In inspecting colonies for American foulbrood, cells with sunken, discolored, or perforated cappings should be opened and examined.

Slide 15. Reader: Control. Burning the infected combs and bees is the safest and usually the cheapest means of dealing with American foulbrood. How to do this will now be illustrated.

Slide 16. Photograph: *An infected colony. To detect American foulbrood in the early stages the brood must be examined. In advanced stages colonies are weakened and the odor of the disease can be detected at the entrance of the hives. Should treatment be delayed until colonies have become weak, the disease may be transmitted to healthy colonies by robber bees.

Slide 17 Photograph: *Kill the bees. The first step in the treatment is to kill the bees. A convenient way to do this is to place a tablespoonful of calcium cyanide on a piece of paper just inside the entrance of the hive. This compound kills the bees in the hive within a few minutes and field bees are killed as fast as they return. The poisonous gas will escape from the hive within a few hours.

Slide 18. Photograph: *Dead field bees at entrance of hive. Should the entrance become clogged with dead bees, they should be pushed back so that returning bees can enter. It is preferable to kill the bees at night to prevent returning field bees from clogging the entrance.

Slide 19. Photograph: *Save the hive only. Hives, bottoms, and covers, when in good condition, can be made safe to use again by thorough cleaning.

Slide 20. Photograph: *Burn the diseased bees and combs. Fire is the most dependable and thorough agent for destroying the bacteria that cause American foulbrood. The diseased combs and the dead bees should be burned in a pit a foot or more deep. When there is danger of robbing, a vigorous fire should be started in the pit and the combs and bees should be thrown into it. If the combs contain considerable brood and honey, a very hot fire will be necessary to burn the brood and honey thoroughly. The burning should be done as soon as the bees are killed, to prevent healthy colonies from robbing the honey and spreading the disease.

Slide 21. Photograph: *Bury the ashes. After the combs and bees have been burned, the ashes and any honey which may run from the combs should be buried under at least a foot of soil. The beekeeper can then be sure that he has permanently removed a source of danger to his own as well as to his neighbors' bees. If all cases of American foulbrood were discovered soon after infection and treated as was this one, losses from American foulbrood would soon cease to be important.

Slide 22. Photograph: *Scrape the hive thoroughly. Wash with hot lye water. Hives from American foulbrood colonies should be thoroughly scraped to remove wax and propolis. Hot lye water and a stiff brush should then be used to wash the hives inside and out. Scorching hive bodies, covers, and bottoms is often resorted to, but in addition, the outside of the hives should be washed with water to remove all traces of honey that may contain spores of American foulbrood. Hive scrapings and wash water should be disposed of so that they will not be accessible to bees.

Slide 23. Reader: European foulbrood. This is another serious brood disease of bees. The following slides (24 to 33, inclusive) illustrate the diagnosis and control of European foulbrood.

Slide 24. Photograph: *Infected comb. European foulbrood is less serious than American foulbrood. It is capable of causing considerable damage to common black and to hybrid bees, but Italian bees are usually successful in warding off this disease. European foulbrood appears in early spring and usually disappears in late spring or summer. During June or July the amount of infection decreases rapidly, and colonies appear to recover, but the disease frequently reappears the following spring. A good honey flow seems to aid recovery. When conditions for this disease are favorable, colonies are seriously weakened or killed.

This comb was taken from a badly infected colony. The brood is irregularly arranged, and discolored, sunken, and perforated cappings are present.

Slide 25. Photograph: *Healthy brood. In a normal colony, brood of different ages is regularly arranged in concentric manner in the combs. Larvae in open cells are glistening white and regularly coiled on the bottom, and the cappings are evenly colored and whole.

Slide 26. Photograph: *Dead brood. Where European foulbrood is present, the brood is more or less irregularly arranged. In advanced cases the usual "pepperbox" appearance is present. The appearance of the brood remains in this disease is widely variable. The larvae usually die while they are coiled in open cells, but many larvae also die while irregularly twisted or fully extended in sealed cells. Irregularity in shape and position of the brood remains is therefore typical of European foulbrood. There is also considerable variation in the color, consistency, and odor of dead brood. Shortly before or soon after death the larvae change from glistening white to dull or yellowish white. Loss of turgidity, decay, and discoloration proceed rapidly after death.

A typical and important symptom of European foulbrood is the distinctiveness of the tracheae or breathing tubes, which appear as radiating white lines on the coiled larvae and as cross markings on the extended larvae. As decay proceeds the color changes from dull, grayish, or yellowish white to light brown, brown, or dark brown. In sealed cells decay continues longer, and the remains

assume darker colors than those in open cells, which usually dry down to light-colored scales.

Slide 27. Drawing: *Many larvae die while coiled. The youngest larvae that die of European foulbrood are coiled on the bottom of the cells. The first symptom seen in diseased larvae (1) is slight loss of brilliance. At about the time of death (2 and 5) the larvae are noticeably less plump and duller colored than healthy larvae (4). The breathing tubes usually show clearly after decay and drying are well advanced (3 and 6), which is an important symptom in diagnosis.

Slide 28. Drawing: *Movements and decay of larvae. Larvae sick of European foulbrood during the active period of their lives move uneasily and assume abnormal positions. The remains of these larvae are usually spirally or irregularly twisted (3, 5, and 6). The digestive tract can be seen through the skin along the back of a healthy larva (1). In sick or recently dead larvae (2) the tract is of a duller gray or yellowish color than in healthy larvae. This tract shows clearly in larvae with their backs turned toward the mouth of the cells, but coiled larvae (4) must be removed from the cells to distinguish it. This symptom is an important one in the diagnosis of European foulbrood.

Slide 29. Drawing: *Decay of extended larvae. A few larvae die of European foulbrood when fully extended during the quiescent period. Since larvae in sealed cells dry more slowly, being protected by the cappings, decay continues longer. These remains frequently become gluelike and a ropiness develops which closely resembles this symptom in remains of American foulbrood (1 and 2). The dried scales (3), which are light brown to dark brown, also resemble scales of American foulbrood.

In European foulbrood dead coiled larvae are removed first by the bees. In advanced cases after the disease has ceased to spread within the colonies, frequently all the coiled larvae are removed, only extended remains which closely resemble those in American foulbrood being left in the combs. It is then difficult to determine in the apiary which disease is present. The difference in the odors of the brood diseases is a reliable additional test when the usual symptoms overlap. Beekeepers and inspectors in particular should become thoroughly familiar with the odors of the foulbroods.

Slide 30. Drawing: Normal, sunken, perforated, and (4-6) removed cappings. The cappings over dead brood soon become sunken and discolored (1 and 2). These cappings are perforated and are removed by the bees as in case of American foulbrood (3 to 6).

Slide 31. Drawing: *Typical remains of young larvae. Here are shown typical remains of young larvae dead of European foulbrood (1 to 4).

Slide 32. Drawing: *Typical remains of older larvae. This slide shows remains of larvae that died at the age when normally they spin their cocoons (1 to 3).

Slide 33. Photograph: *Introducing an Italian queen. European foulbrood does but little damage where Italian bees are kept and good beekeeping is practiced. Infected colonies should be left queenless for about 10 days and then

requeened with Italian queens. All colonies should be kept as strong as possible by uniting and by other means.

Slide 34. Reader: Parafoulbrood. This is a recently discovered bacterial disease of the bee brood. The following two photographs show the appearance of this disease.

Slide 35. Photograph: *Early case. Parafoulbrood is known to exist in limited areas in Florida, Georgia, South Carolina, and North Carolina. Remains of the younger larvae dead of parafoulbrood closely resemble those dead of European foulbrood, and the remains of extended larvae and pupae are sometimes difficult to distinguish from remains of American foulbrood. Sick larvae move uneasily, and frequently occupy abnormal positions in the cells. They are not so plump as healthy ones and are of a dull white color. After death the color changes to yellowish or grayish white and finally brown scales are formed. In sick and recently dead larvae the intestines can be seen through the skin along the back as a dull yellowish or grayish white streak. In early cases it is difficult to distinguish in the apiary parafoulbrood from European foulbrood.

Slide 36. Photograph: *Advanced case. In advanced cases when brood remains are abundant, it usually is possible to distinguish parafoulbrood in the apiary. There are usually more remains in sealed cells than in the case of European foulbrood, and on rare occasions pupal remains are found, sometimes with protruding tongues. In some of the dead larvae the breathing tubes show clearly, but this characteristic is less distinctive than in European foulbrood. Remains in sealed cells assume a ropy consistency and color, similar to these characters in American foulbrood. The principal differences are that the color is frequently reddish brown instead of chocolate brown, and the threads are not so fine as in the case of American foulbrood in a late stage of decay.

An important character in distinguishing parafoulbrood from other brood diseases is the odor. Although remains in open cells most frequently do not develop a characteristic odor, remains in sealed cells usually develop an intense, putrid odor. This odor is quite different from the odor of American foulbrood, and although it resembles the odor of European foulbrood it is frequently much more intense.

Slide 37. Photograph: *Scales of foulbroods and sacbrood. In this picture the brood remains of parafoulbrood (second row) can be compared with the brood remains of European foulbrood (top row), American foulbrood (third row), and sacbrood (bottom row); at the left in each row is shown a scale of one of the youngest larvae which died of the particular disease represented. Each succeeding scale is of a larva which died at a slightly older age than the one preceding it. Note that the scales of the youngest larvae which died of parafoulbrood resemble most closely remains of larvae which died at the same age of European foulbrood (1), whereas the remains of extended larvae and pupae resemble the remains of larvae which died of American foulbrood (2 and 3).

Scales of sacbrood are shown in the bottom row. It is usually easy to distinguish them from scales of the foulbrood diseases. The symptoms and decay of larvae dead of sacbrood are shown in the next four pictures.

Slide 38. Reader: Sacbrood. This is the most common disease of the bee brood, but it causes slight damage. The following illustrations (slides 39 to 42, inclusive) show the appearance of the disease.

Slide 39. Photograph: *An advanced case. Although sacbrood is by far the most prevalent of the brood diseases, only in rare cases does it noticeably weaken colonies. A few larvae are killed during spring and early summer, but sacbrood disappears of its own accord by midsummer. This picture shows artificially produced sacbrood. Cases as severe as this one are rarely caused by natural infection.

Slide 40. Photograph: *Dead brood in the cells. The heads of larvae dead of sacbrood are practically always curved sharply upward, whereas in other brood diseases the heads of extended larvae rest on the floor of the cells. This characteristic, which is clearly shown here, is an important symptom in the diagnosis of sacbrood. Another distinction between remains due to sacbrood and those due to foulbroods is that the consistency is more watery and granular, and the skin remains tough. The remains of sacbrood can be removed entire from the cells during all stages of decay.

Slide 41. Drawing: *Stages in decay. After death from sacbrood, larval remains gradually assume a dark color, the deepest shades appearing at the head end (1 to 6). During decay and drying the larvae gradually settle on the floor of the cell, but the head continues to curve sharply upward (4 to 6). When thoroughly dry the scales are nearly black and are tough or brittle (5). A slight touch is sufficient to loosen them, since they do not adhere to the combs.

Slide 42. Drawing: *Stages in decay. This picture shows another view of the steps in decay and drying of sacbrood remains (2 to 6). Notice the wavy outline in the partially decayed remains and scales. A healthy larvae also is shown (1).

Slide 43. Reader: Fungous diseases. Diseases caused by fungi affect both brood and adult bees, but the losses are slight. Three photographs are shown to illustrate these diseases.

Slide 44. Photograph: *Dead brood in comb. Brood remains resulting from fungous diseases are readily distinguishable from remains due to other brood diseases, since they retain their general form and eventually become hard and chalklike. Dead larvae also remain white or grayish white, but the surface may be discolored by the spores of the fungus.

Slide 45. Photograph: *Brood remains. The dried remains, commonly known as mummies, are easily removed from the cells.

Slide 46. Photograph: *Fungus on adult bees. This picture shows workers and drones dead from mycosis. If drying is not too rapid, the fungus grows through the exoskeleton and produces spores on the surface of the dead bees. The abdomens of bees sick or dead from mycosis are firmer than those of bees dead from other causes.

Slide 47. Reader: Nosema-disease. This disease weakens colonies by killing adult bees. The appearance of Nosema-disease is shown in two slides.

Slide 48. Photograph: *Diseased (left) and healthy (right) stomachs. Nosema-disease is difficult to distinguish in the apiary. Diseased bees cannot fly, but they crawl actively. The abdomens may be normal or swollen, but these symptoms are also present in bees affected by other disorders.

It is frequently possible to determine if this disease is present by examining the stomach of suspected bees. Since Nosema attacks the tissues of the stomach or ventriculus, this organ is frequently white and swollen in affected bees. The difference between the appearance of the ventriculus in affected and healthy bees is shown in this view, which represents an extreme case. In the early stages of infection the stomach swells, but later it shrinks to about normal size.

Slide 49. Reader: Septicaemia. Septicaemia (a sort of blood poisoning) of adult honeybees kills individual bees but rarely causes any noticeable weakening of colonies. The principal symptom is shown in the following slide.

Slide 50. Photograph: *Dismembering of adult bees is the principal symptom. In septicaemia the tissues decay rapidly, and after 1 or 2 days the divisions of the body fall apart. Sick bees resemble chilled bees, and either leave the hive or are carried out by other bees. Before death the blood loses its clear, pale-brown color and appears milky. A drop of blood for examination can be obtained by squeezing the thorax.

Slide 51. Reader: Acarine disease. This disease, common in Europe, does not exist in this country. To prevent importation of the parasitic mite which causes it, all honeybees imported into the United States must be examined at the bee-culture laboratory of the United States Department of Agriculture.

Slide 52. Photomicrograph: *Discolored trachea containing mites. Acarine disease is caused by very small mites which invade the tracheae or breathing tubes. In cases of recent infestation symptoms of acarine disease are not distinguishable in the apiary. In advanced cases the affected bees are unable to fly, and the abdomens may be swollen. Following a period of inclement weather, these bees crawl from the hive in large numbers. This is an important symptom, frequently referred to as "mass crawling." A more dependable symptom, which can be determined with a hand lens is discoloration of the first thoracic trachea. Healthy tracheae are pure white, but when mites are present the tracheae are blackened in irregular spots. This picture shows both discolored and normal tracheal branches. In examining the tracheae it is best to use crawlers, since mites leave the bees soon after the bees die.

Slide 53. Photomicrograph: *Mites removed from trachea. Mites breed and multiply within the tracheae of honeybees; consequently all stages are found in infested tracheae. This picture shows eggs and mites taken from a single trachea.

Slide 54. Reader: The bee louse. This insect, imported from Europe, is gradually spreading in this country. It causes damage to adult bees and spoils the appearance of comb honey.

Slide 55. Photomicrograph: The bee louse. The young bee louse emerges in much the same manner as does a young queen, by lifting up one side of a lid formed by a circular cut made while it was in the larval stage (1). Young lice are pure white (2) but soon turn reddish brown, the color showing first on the head and thorax (3). Soon after emerging, the young lice crawl onto the backs of bees, preferably the queen, where they spend the greater part of their lives (5). The mature louse, which is the stage most commonly seen, is shown at the lower left corner of this picture (4).

Slide 56. Photograph: *Damage caused by the bee louse. Some authorities are of the opinion that the bee louse causes considerable damage, and others hold that the damage is negligible. The adult bee louse attaches itself to a queen (1) or worker bee and steals food from the bee's mouth. The larva burrows through the cappings of honey. From 30 to 100 bee lice have been found on a single queen, and observations of beekeepers indicate that the activities of a queen are affected when it is host to such a large number of bee lice. Larval tunnels cause comb-honey sections to appear wormeaten and unsightly (2).

Slide 57. Cover pages of Department Bulletins 431, 780, 804, and of Technical Bulletin 149.

Slide 58. United States Department of Agriculture lantern-slide and film-strip service.

UNITED STATES DEPARTMENT OF AGRICULTURE
EXTENSION SERVICE, C.W. WARBURTON, DIRECTOR—OFFICE OF COOPERATIVE EXTENSION WORK, C.B. SMITH, CHIEF

Lecture Notes for Lantern-Slide Series 172

HANDLING BEES FOR SUCCESSFUL BEEKEEPING

Prepared by
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Bureau of Entomology

This series of 38 slides supplementing Farmers' Bulletin 447, Bees, and illustrating various important steps necessary in handling bees successfully, was prepared from illustrations selected and arranged in cooperation with the Office of Bee Culture Investigations of the Bureau of Entomology. The series is available for loan from the Office of Cooperative Extension Work, Extension Service, United States Department of Agriculture, Washington, D. C.

Slide 1 (38018-B) Title.

Slide 2 (28650-C) Credit statement. The bee-culture laboratory of the Bureau of Entomology, United States Department of Agriculture, will send free of charge a list of books and journals on beekeeping, including a list of its own bulletins on that subject. These bulletins contain much that will be of help to the beekeeper in his study of the needs of the honeybee.

It is the aim of the bee-culture laboratory, in its publications, to emphasize the importance of the fundamental principles concerned with the life of the bee colony, because no beekeeper can be continuously successful without a good knowledge of bee behavior.

Although a good crop of honey occasionally is produced by someone who knows little about how to handle bees, yet no beekeeper can be successful under varying seasonal conditions unless he has devoted some time to finding out why his bees behave as they do.

A beekeeper can do almost anything with bees that he desires, if he works in accord with their natural reactions to their surroundings, for it must be remembered that bees are wild animals and have never been domesticated. One does not call bees by name to come and be fed or to be petted or punished, nor can one compel one single bee to do anything it does not want to do. Beekeeping teaches gentleness and patience. It is worse than useless to use force with a bee.

Though bees have been handled by man since the dawn of history, they live and work now just as they did in ancient Egypt, and probably far back beyond any record we have of them. Man feeds domestic animals such food as he sees fit, but he has no control over the food or habits of the bee, hence it goes on its unchanging way, and man can be successful with bees only by adapting his methods of work to their ways.

IMPORTANT. - This lantern-slide series is available for loan both on film strip and on glass slides.

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Man also must learn thoroughly the principles upon which depend the simple manipulations of the hive, so that he may most efficiently open hives, handle frames, find queens, and do the other necessary work of handling bees to have them do what he wants them to do.

Slide 3 (1672) Photograph: Apiary with hives on winter case stands. The most interesting of all work with bees is the actual handling of them. The timid and inexperienced may have a little trouble at first, but with patience and care the beekeeper soon becomes so fascinated with this part of beekeeping that he is likely, many times, to open hives unnecessarily, wasting not only his own time and energy, but that of the bees.

To learn to follow the work of the colony from outward signs, we must know the meaning of the things we see. The instinct of the bee is to attack and drive away anything that disturbs its home. On the approach of smoke, the bee does not fight, but fills itself with as much honey as it can carry. If the smoke continues and great heat comes, the colony simply moves out, carrying what stores it can, to build a new home in a safe place. Therefore, the beekeeper uses smoke when handling his bees.

Slide 4 (5937) Photograph: Smoker, hive tool, and veil. A smoker, a hive tool, and a veil are essential articles. The veil may be of wire cloth, as shown in the picture, or of bobbinet or other material. The wire cloth is advisable for strength and because it does not blow against the face.

Slide 5 (1050) Photograph: Small apiary with windbreaks. Bees sting less in an apiary where there are plenty of shrubs among the hives, particularly if it is well sheltered from the winds by trees. Bees sting one person more than another largely because they notice a difference in behavior in different persons. Some things can be done to the bees with safety, but certain other things will cause them to sting. Man can do what he desires with bees only if he works in accord with their peculiar habits; otherwise, he will be stung badly. Bees are more inclined to sting on some days than on others, particularly on cool, cloudy days at the end of a nectar flow, and, if they must be handled on such days the beekeeper must exercise unusual care. He will make sure, before he attempts to open a hive, that his smoker is in first-class order and producing dense, cool, white smoke. Burlap sacks, cut-up corn cobs, excelsior, sumac bobs, all make good fuel. He will blow a whiff of smoke at the entrance before he very gently pries up the cover a little. More smoke is used as the cover is removed.

Perhaps some will feel that slow motions waste time, but more work can be done in a day by working deliberately and by closely and carefully watching for any disposition on the part of the bees to resent intrusion. Here rests a secret. To one who is accustomed to handling bees, there is a certain indescribable action of bees which shows that they are ready to sting. A little smoke at the right time takes all the fight out of them. If bees show a quick, nervous movement, as though ready to dart at one's hands, a few light whiffs of smoke are needed. Only a very little smoke is needed, but that little must be used, and must be given at the right time, or trouble will begin.

A good time to begin work is on some fine spring day when bees are flying busily, carrying nectar and with bodies and legs laden with pollen dust. The beekeeper will then put on his bee veil, get his smoker going well, so that it will not go out when most wanted, and go to the beehives.

Slide 6 (1650) Photograph: Beekeeper with veil, smoker, and hive tool. A smoker and hive tool are always necessary when one works with bees. A veil sometimes may not be needed, but it does not pay to try to work without one. Too much time is wasted with hands up to face, with head in a clump of bushes, or with the beekeeper in retreat from the scene of action.

When a bee sting is received, it should be removed at once. If not removed, it will gradually work into the flesh, discharging the contents of the poison sac, and the results will be much more severe than if the sting had been removed immediately.

Slide 7 (23613-B) Photograph: Sting and poison glands of the queen. Many experienced beekeepers have learned to know the feeling produced when a bee lands on the skin with the intention of stinging. Just as soon as a cross bee lands and begins to sink its claws into the flesh, preparatory to stinging, the experienced beekeeper, even before the bee has begun to sting, or when the first prick is felt, crushes the bee and rubs the sting out in one motion. If the bee is on the hand, this can be done by rubbing the hand quickly against some convenient part of the clothing, as the leg of one's trousers, rubbing the sting out sidewise. Soon this will be done automatically, and so quickly that no after-effects follow from the sting. If, however, the sting has fairly entered the flesh, the bee usually will tear itself away from the sting. Whether or not this occurs, one should quickly scrape out the sting. This can be done with the thumb nail or the edge of the hive tool. The point to be remembered is that the sting should be removed at once without placing pressure on the poison sac. If one attempts to remove the sting by grasping it between the thumb and finger, the result will be to compress the poison sac and force much of the poison into the wound, rendering the effects of the sting much more severe than if it were scraped out, as with the thumb nail.

Remedies of all kinds are of little avail against bee stings, and the best thing to do is to pay no attention to a sting.

If unfortunately, one receives a great many stings at one time, or if one is of that very small number affected seriously by bee-sting poison, some treatment may be useful. Occasionally even a single sting will cause the body to break out in white or red blotches, or the action of the heart may be seriously affected. Fortunately, such cases are rare, as are cases of very severe stinging, and, when one occurs, a doctor should be called at once. In the meantime, the patient should lie down, and a towel, wrung out of water as hot as can be borne, may be applied to the affected parts. These hot applications may be alternated with applications of cold water. Sometimes a warm bath is helpful. In all cases the patient should be kept quiet. The physician probably will administer adrenalin, which is almost a specific for collapse from bee stings. It must be given hypodermically and must be very fresh. Tablets are not so reliable. Adrenalin is of little real value in relieving the pain. If used at once it retards the swelling, but not the pain. Its stimulating action is very short. Frequently, to obtain lasting results, it must be given every few minutes, and the treatment continued some time. Adrenalin might be dangerous to persons suffering from high blood pressure.

Though this information sometimes may be useful, dangerous effects from bee stings are so rare that many beekeepers who have handled bees all their lives have never observed serious results from bee stings. Almost always severe stinging is the result of either fear or carelessness on the part of the beekeeper.

Slide 8 (5942) Photograph: Gloves and bee brush. A brush like this is often useful for brushing bees off the combs. If the novice is very timid he may, in the beginning, put on a pair of long cloth gloves. Bees are more inclined to sting leather gloves or woolly, fuzzy clothing than a smooth-surfaced, light-colored cloth. Wearing gloves is a bad practice, however, because it irritates the bees unnecessarily, and is apt to result in killing bees because of clumsy fingers. If gloves are worn, those without fingers, as shown in the illustration, are preferable. The bottoms of the trousers may be tied with string, or leggings may be worn, but this precaution is seldom necessary if one is careful not to scatter bees over the ground. A woman is advised not to wear low shoes and black stockings when working with bees.

Usually not all these precautions are necessary, and one cannot consider himself an expert with bees until he feels that he needs no gloves, but only a veil and smoker. Although stings usually cease to affect one except for the pain during the first few moments, it is not advisable to allow oneself to be stung unnecessarily.

Slide 9 (1651) Photograph: Approaching the hive. Thus properly clad, with a smoker in one hand and a hive tool in the other, one approaches the side of the hive; not the front, where the guards are watching the entrance and where the bees going to and coming from the field are ready to use their stings against anyone who stands in front of their door, interfering with their regular routine. Bees have their own ways of doing things and the beekeeper might as well remember, from the beginning, that he will succeed best by conforming his actions to their ways, since they will continue doing things in their own way.

So the beekeeper approaches the side of the hive and puffs a little smoke at the entrance, just enough to give the guards an intimation that the master is coming along. Often no smoke at the entrance is necessary if honey is coming in, but the beekeeper will learn that by experience.

Slide 10 (1652) Photograph: Prying up inner cover. As gently as possible take off the outer cover and place it, upside down, about where shown in the picture. Jarring the hive does not improve the temper of the bees. Insert the hive tool under the inner cover, pry it up a little, then use a warning whiff of smoke at the crack; twist the hive tool to loosen the cover and blow more smoke over the frames, not down into the hive between the frames. Smoke would be blown down between the frames if it were desired to drive the bees out of the hive. When opening a hive one should not blow so much smoke over the frames that the bees suspect a fire is near at hand. Too much smoke often causes black or hybrid bees to stampede and to run out of the hive. Only enough smoke is needed, at just the right time, to drive back any bees that show signs of attacking.

Slide 11 (1653) Photograph: Cover off, ready for removal of frames. Many stings are avoided by careful attention to the action of the bees at the time the cover is removed from the hive. When they stick their heads up in rows between the frames, alert, or stand high on their legs, moving their heads this way and that, ready to take wing, they are on guard, and need another whiff of smoke to send them back down between the combs to fill themselves with honey. Not much smoke is needed to keep a colony from becoming enraged, but once the novice fails to use a little smoke frequently and at just the right time, a colony of bees may become aroused, and then torrents of smoke are required to cause the bees to quiet down again.

In the enthusiasm of his interest in the bees and their work, the beginner is all too apt, when he opens the hive and begins work, to watch the bees, forgetting about his smoker until the bees begin to sting. Then, if the fire is out in his smoker, he is out of luck. All he can do is to retreat hastily to the house and again get his smoker going, pouring out clouds of that cool, dense white smoke which is so much more effective than hot blue smoke, which burns and enrages the bees. It is much better to use the smoker little and often and thus keep the bees always quiet. Colonies of bees which have been permitted to sting badly today are likely to sting badly tomorrow. Keep the bees quiet by proper handling, and do not permit them to sting like furies.

Slide 12 (1654) Photograph: Hive open; first frame removed. With the hive open and the bees quiet, work can really begin. The frames probably will be stuck together by propolis. They may be pried apart with a hive tool until one of the frames can be lifted out. It usually is best to remove a frame near one side of the hive, where there are fewer bees and one will not so readily disturb or injure the queen, but it is often convenient to remove a frame nearer the center of the hive body. When the frames have been pried apart to give more space to the frame to be removed, the first frame may be removed. This frame, and all frames, should be lifted up carefully, straight up, so as not to crush bees between the end bars of the frame and the hive, or between the combs themselves. Nothing angers bees more quickly than the odor of crushed bees.

Usually, after work has begun and the bees are quiet, the smoker may be set down in a convenient place or held between the knees, as in this picture, and frame after frame lifted without the beekeeper's receiving a single sting. But, all the time, the smoker must be used frequently enough to keep the fire going, so that plenty of smoke may be ready when needed, as in the event of a nervous beginner's dropping a frame or in some other way doing something to start the bees stinging.

Slide 13 (1655) Photograph: Setting off upper hive body. If no brood is found in the upper story, the beekeeper may wish, at once, to examine the lower body, or brood chamber. The upper story may be pried loose from the lower one with the hive tool and then set off, with a swinging motion, upon the inverted hive cover. This is done to avoid crushing the bees, as the bottoms of the frames are flush with the lower edge of the hive body.

Especial care should be taken not to pinch or to kill any bees. The pinching and crushing of a few bees may quickly arouse the whole colony. Always remember to make no quick movements over the hive. One may move his hands as quickly as he wishes elsewhere, but over the hive quick movements are almost sure to cause

several bees to fly up and attempt to sting. Always be deliberate and cool in the manipulation of bees, remembering that, unless aroused, they are not inclined to resent handling. Nervousness or any quick movements on the part of the operator seems to anger bees.

Slide 14 (1657) Photograph: Removing a central frame from hive. Though this picture shows a central frame being removed, a beginner should take out the first or second frame at the side nearest him, as the queen is less likely to be found at the side of the hive. If she should be on the first frame removed, there might be danger of injuring her as the frame is withdrawn and, as the queen is the foundation of the colony, she must not be endangered.

Slide 15 (1659) Photograph: Looking at a frame. It is a common practice to set the first one or two frames on the ground, leaning them against the hive, as shown in the picture, but here, again, one must remember the habits of the bees and how they are affected by their surroundings. A queen, heavy with eggs, may find it difficult to cling to a comb when handled, and may tumble into the grass and be lost, or a nervous virgin queen may fly away and enter some hive where her presence will cause trouble; or a comb set down on the ground in the hot sun may be melted down, or young larvae may be injured by the heat of the sun. If no honey is coming in, robber bees may discover the exposed honey and serious trouble may be started.

On the whole, it is a better practice to place the removed frames in an extra hive-body, placed, for instance, on an extra cover, so that the bottoms of the frames do not touch the ground, killing bees. This hive-body and also the first one set off should be covered, if robber bees are about, but we are now considering how to handle bees when honey is coming in and bees are not inclined to rob. Robbing is like stinging, in that prevention is better than cure, and if bees are hunting around and looking for a chance to rob, great care should be taken not to expose honey and frames a moment longer than is necessary; everything should be covered as quickly as possible, and not only covered, but covered bee-tight. Again, remember that prevention is better than cure.

Slide 16 (1656) Photograph: Further work with brood chamber. After the first frame has been removed carefully, by prying the frames apart to give room for lifting it out without pinching or killing bees, the others may be handled readily. Loosen them with the hive tool, removing one after another, examining them, and putting them back in the hive, toward one side, leaving room to take out the next comb. In arranging the frames in the hive during the spring overhauling of the brood nest, or at any time when such work seems necessary, it is well to place at the south side of the hive a frame containing much pollen. The bees commonly arrange the brood nest in that way - first at the south side of the hive a frame of honey and pollen, and then the brood combs. The brood combs, unless the bee-keeper has some good reason for placing them otherwise, should be placed in the same order in which they were originally, as the bees tend to keep the brood nest in a spherical shape, expanding it as they become strong enough to cover more combs. The combs in the middle of the hive contain larvae and pupae, and the combs toward each side contain mostly pollen and honey.

Not often, unless the brood nest is crowded, will any brood be found in the outside comb; hence, in opening a hive, it is comparatively easy to remove safely a frame at one side which is not likely to contain any brood and on which the

queen is seldom found. Having removed this frame, usually broodless, carefully and without pinching or hurting any bees, the beekeeper can set it outside the hive, or better, as has been said, in an empty hive body.

Slide 17 (1658) Photograph: Holding a frame and looking for queen. Frame after frame is then to be pried loose and lifted out. At the same time the operator should glance at the surface of the next comb as it hangs in the hive, as a queen often may be found in that way before she disappears around the edge to the opposite side - the dark side of the comb. The frame which has just been lifted out should then be looked over carefully for the queen.

In the first spring examination one can more easily find the queen than at a later time, because there are not so many bees in the hive but, unless one wishes to clip the wings of the queen, there is not much use wasting time in finding her. To know that she is present and properly at work is all that is needed. The amateur spends much more time looking for queens than does the commercial beekeeper, who asks, "What will you do with the queen after you do find her?"

Slide 18 (1663) Photograph: How to look for queen, larvae, and eggs. After taking this first glance at the frame as he removes it from the hive, the apiarist should stand with his back toward the sun and the top bar of the frame toward him, the strong light coming over his shoulder. In this way, he not only can find the queen readily, but can see to the bottom of the cells, where eggs or young larvae will be found under normal summer conditions if a queen is present.

Slide 19 (58017-B) Photograph: Part of brood comb showing bees, and the larvae in cells. This picture shows the normal appearance of a brood comb with sealed brood and larvae of various ages. When eggs are found placed normally in the cells, as in the upper left-hand side of this picture indicated by the circle no. 1, no more time need be spent looking for the queen unless there is some particular reason for seeing her. Eggs and young larvae regularly placed and in sufficient abundance are sufficient guarantee that a queen is present in the hive and doing her duty.

This picture shows the development from the egg to the full-grown larva. At first the larva lies coiled in the cell, as at no. 2. Later, it grows too large to lie coiled and then straightens out in the cell, is soon sealed over, as at no. 3, then spins its cocoon and begins to change into the full-grown bee.

Slide 20 (1661) Photograph: The queen found. If the queen is not found on the frame which has been lifted out, the frame is set into the empty hive body, which in this picture is shown resting on a corner of the hive cover and behind the top story as it rests on the cover. Placed thus, the frames do not touch the ground, as they are placed in the body after being looked over, and no bees are crushed. Frame after frame is lifted out and examined until the queen is found perhaps busily engaged in laying eggs. Walking about over the comb until she finds an empty cell prepared for her use, she inserts her head into the cell, then turns about and lowers her abdomen into it, depositing a single egg at its bottom. As the queen goes about the hive, usually a more or less distinct ring of worker bees surrounds her whenever she stops. The bees clean her body and feed her every few minutes while she is engaged in laying eggs.

Until the queen is found, the process of lifting out one comb after another and examining it is continued. As each comb is lifted out, one should look first on the face of the next comb as it hangs in the hive, and then on the opposite side of the frame in his hands, and last on the side next him and exposed to the light, as the queen is usually found on one of the shaded sides. In this way one should keep on until all the frames are set over into the empty body or until the queen is found.

For the beekeeper with a few colonies, and for one who cannot give the best of attention to his bees, clipping queens is a good practice. It is not usually done by the large producers of extracted honey, though it is by numerous producers of comb honey. It is a good practice if it can be done along with some other necessary springtime examination, so that not too much time is consumed.

Slide 21 (5901-a) Photograph: Catching queen for clipping. There are many ways of catching and clipping the queen, but a good method is that shown in the picture, where she has been picked up from the comb by both wings between the thumb and forefinger.

Slide 22 (5900-a) Photograph: Catching queen for clipping.

Slide 23 (S-8667-C) Photograph: Clipping queen's wings. From the thumb and forefinger of the right hand, as in the previcus picture, the queen is shifted to the left hand. If permitted to touch the thumb of the left hand, she will at once grasp it with her legs, when the forefinger should close against the thumb, catching all, or at least two, of the legs on one side of the body. This will hold her securely in position for clipping and she will usually remain quiet and not flutter her wings.

With the queen quietly in position and with the legs on the one side held between the thumb and forefinger, a pair of small scissors is used to clip off most of the larger wing on one side, taking merely the very tip of the smaller wing. Sometimes a queen will fly unless a bit is clipped off the smaller wing as well as the larger one. The second year, if a queen is found with one clipped wing, the wing on the other side may be clipped. Thus any queen which is found with two clipped wings is known to be 2 years old, and except in special cases, should be replaced.

Catching and holding a queen is a more simple operation than it appears to be, yet it must be done with care, so as not to clip off a leg or to injure the queen in any other way. The thorax of the queen is firm enough for one to hold in the fingers without injury, and many prefer to hold the queen by the thorax when clipping, instead of by the legs. Care should be taken not to clasp her by one leg only, as she may twist around and injure herself, or pull loose and fly away. Others prefer to hold her on the comb by a finger or two while cutting her wings. Whatever way is used, one should be careful not to pinch the abdomen, which is very soft and often is distended with eggs and easily injured.

Slide 24 (1670) Photograph: The effect of too much smoke. It sometimes happens that the queen is not found, even when all the frames have been removed and set into the empty hive. Then the bees on the inside of the hive and the floor board should be looked over, lest the queen be among them. With Italian bees the queen seldom leaves the combs if they are properly handled, but blacks and hybrids

sometimes become nervous and run about over the frames, even pouring out of the entrance of the hive, and making it difficult to find the queen. If the queen is not found within the hive, the frames are returned one by one, the operator looking for the queen each time until all the frames are back in the hive.

If it should occur that the queen is not found on this second search, it will be best to close up the hive, wait until the bees are quiet, perhaps until the next day, and then try again.

In this work of finding a queen, care must be taken to use only a little smoke--just enough to keep the bees from stinging. If too much smoke is used the result will be as shown in this picture; the bees will begin running about, and further search at this time will be almost useless. Use as little smoke as possible, but on the other hand, one should not become so interested in the search for the queen that the smoker is forgotten; if the smoker is not used at all the bees may become so aroused that considerable smoke will be needed to quiet them, and the chance of finding the queen will become very small.

Slide 25 (1667) Photograph: Frame of honey--mostly sealed.

Slide 26 (38016-B) Photograph: Frame of sealed brood. Seldom does the experienced beekeeper find it necessary to look over many brood frames to find the queen. During the breeding season she is seldom found on frames of honey (slide 25) as shown in this picture; or on frames of sealed brood (slide 26) such as this, where only a little unsealed brood remains, as at the right, shown by circle no. 1, and where honey is just being sealed, as shown at no. 2. Instead, the queen is usually found near the outside of the brood nest on combs which contain many empty cells, or on central combs from which young bees have recently emerged, the cells then being cleaned and polished by the workers in readiness for another lot of eggs. Therefore a beekeeper learns to spend but little time looking for a queen on a frame where he does not expect to find her. A mere glance at a comb of sealed brood or honey is sufficient, then he passes on and carefully looks over those frames on which experience tells him she is likely to be; although, as has been said, he seldom looks for a queen when the condition of the brood and the colony indicates that she is present and is doing good work.

Slide 27 (38015-B) Photograph: Frame covered with bees protecting brood. When a frame of brood is removed from the hive in cool weather the bees cover the brood and protect it from being chilled. Often there are so many bees that it is difficult to know just what is in the comb. Sometimes this does not concern us, but when, as on this comb, we find some queen cells (see arrow), we may want to get the bees off the comb so we can find out why queen cells are present. If the queen cells are to be saved, we brush off the bees carefully without jarring the comb, which might injure the immature queens in the cells.

Slide 28 (38014-B) Photograph: Frame with bees shaken off--queen cells. If, however, we do not expect to use the queen cells, we merely give the comb a quick shake and almost all the bees drop off, leaving the bare comb as in this picture. Dr. C. C. Miller explained the secret of shaking bees off the combs, which is to take them by surprise and shake them off upward when they are hanging on to prevent falling off downward. To do this, one takes the comb in both hands, holding the top bar loosely between the fingers and the palm at the base of the thumb, makes a downward movement with it, then a quick upward movement, stopping the up-

ward movement quickly so that the top bar strikes the base of the thumb quite firmly. The result is that the comb stops suddenly, causing the bees to be shaken off upward before they have a chance to grasp the comb firmly again. A little practice will make one expert in thoroughly freeing combs from bees, but the motions can be learned best by watching an expert operator.

Slide 29 (38013-B) Photograph: Worker brood with open queen cell. On this comb we see almost all that is to be seen in the brood nest: Sealed honey (circle no. 1) and unsealed honey (circle no. 2), cells of pollen (circle no.3), sealed worker brood (circle no. 4), drone brood (circle no. 5) with its high, rounded caps, near the bottom of the frame, and queen cells (circle no. 6), and the arrows point to emerging worker bees; but no eggs or young larvae, their lack indicating that the queen is not present, as is also suggested by the presence of queen cells. Queen cells on the lower edge of the comb, such as these, often indicate that a colony has swarmed, as they have been built around eggs laid in cell cups, whereas cells built when a queen has been killed or otherwise lost are built as in the following picture (slide 29) on patches of worker comb, by enlarging and destroying several cells to make room for the queen cell. In this picture we see such a queen cell from which a queen has just emerged, the cap which she has cut off being still attached to the cell. The large cells which are seen in the lower right-hand corners (see arrow) are stretched or imperfect cells in which worker brood will not be reared, although they may be used for drone brood.

Slide 30 (5909) Photograph: Use and nonuse of comb foundation.

Slide 31 (1760) Photograph: Embedding foundation. This picture shows the contrast between the upper comb, which was built naturally by the bees, without the use of comb foundation, resulting in a comb composed almost entirely of the large or drone cells, and the lower comb, which was built from a full sheet of comb foundation into a good worker comb. Except in rare instances, as in the case of weak colonies and nuclei, too much drone comb will be built by the bees unless they are supplied with full sheets of foundation in each frame.

In making an examination of the brood nest, if one finds defective combs or combs containing much drone brood, they should be shifted to a position near the wall of the hive, where they will be occupied with pollen and honey instead of brood; or they should preferably be replaced at once with good combs or foundation. Either wired foundation or wired frames and full sheets of foundation should be used in the brood nest to obtain good combs. This picture (slide 31) shows the wires being embedded with a spur tool, but a better way is to use electricity for embedding, as the heated wires sink into the wax, which closes over them, holding the wires much more firmly in place than when the spur embedder is used. Too much emphasis cannot be placed upon the necessity of having only good worker combs in a hive.

Slide 32 (1664) Photograph: Imperfect comb. It is surprisingly easy to have the brood capacity of a hive cut down a third or even a half by the use of such imperfect combs as the one in this picture. Notice that all the upper part of the comb, the ends, and the lower edge, are composed of stretched or badly shaped and very large or too small cells, in which worker brood will not be reared. When any part of a comb in the middle of a brood nest is not full of brood, that comb probably is a poor one. When brood is not reared right up to the top bar, it usually is because these upper rows of cells are stretched out of shape by sagging

foundation. When an inch or two of honey is permitted to remain next the top bar during the height of the breeding season, one may be almost certain, provided the queen is a good one, that the cells which are not full of brood are not fit for brood rearing. If the queen is an old one or the colonies want to rear drones, such combs often contain much drone brood.

Imperfect combs, resulting in weak or less than full-sized colonies, are among the greatest sources of loss to beekeepers.

Slide 33 (S-8681-C) Photograph: An almost perfect comb. No one can afford to have anything else in the brood nest than the most nearly perfect worker combs that he can produce. This picture shows such a comb, filled almost solidly with sealed brood up to the top bar. A few cells of honey are in each corner at the top, but it is about as good a frame of brood as one could wish to have.

In addition to preventing loss of effective brood-rearing space, clean, straight, all-worker combs may be handled with so much greater rapidity in all apiary operations, that crooked and drone combs in a hive should not be tolerated longer than until they can be replaced. Well-made hives and good combs handled without crushing bees, and proper use of just enough smoke at just the right time, are essentials in doing any work with the bees.

Slide 34 (5849) Photograph: Group of hives on cement base. Besides having good combs in the brood nest, another essential to success in beekeeping is plenty of hive room for the colony. To obtain a big crop of honey one must have a large colony of bees. To have a large colony of bees, at least a 2-story hive must be used. Under most conditions, one hive body cannot contain enough room for the bees, for plenty of winter and spring stores, and for spring brood rearing. Except for cellar wintering or under unusual conditions, bees should be wintered in two stories. One of these stories may be a shallow super, if desired. The queen excluder in the tall hive in this group is above the second story. At the proper time it usually is placed between the lower hive body and the second one, with the queen below it. More and more beekeepers are finding out the value of plenty of hive room in successful beekeeping. The best crops of honey cannot be obtained without attention to this point.

The cement hive stand shown in this picture is a great help in keeping the hives level, giving them a proper slope toward the front, and protecting the hive bottoms from dampness, besides adding to the neat appearance of the apiary.

Slide 35 (1668) Photograph: Closing up the hive.

Slide 36 (1669) Photograph: Putting on outer cover. When ready to close the hive, the frames if self-spacing may be crowded over against the far side of the hive, the last comb put in place, and then the whole set of frames moved back a little from the far side of the hive, so that neither of the two outside combs is too close to the outside of the hive. If a comb is too close to the hive wall, it is likely to be fastened to it by brace combs, disfigured, and made largely useless, whereas, if too much space is left, that side of the comb will be drawn out too far or pieces of comb will be built in the extra space. When the combs in the brood chamber have been properly spaced, the super is swung and slid into place, the inner cover is replaced with the use of a little smoke, (slide 36) and the outer cover is put on. If there is any tendency to rob, indicated by disturb-

ance and fighting around the entrance, the entrance closer should be put in place, leaving room for only a few bees to enter at a time. The guards then soon take up their duties and defend the hive. It should always be remembered that a colony of bees should be disturbed as little as possible and the combs exposed no longer than necessary.

If these suggestions for examining hives, which are in accordance with the habits of bees, are followed, little difficulty need be experienced and few or no stings will result; but woe to the operator if he drops a comb when cross bees threaten, or if he makes quick or nervous movements over the open hive. He may also expect to be stung if he stands in front of the entrance of the hive, in the way of the flying bees, or if he forgets about occasional use of the smoker, until, when the bees begin to sting, he finds the fire in his smoker gone out and he is compelled to retreat hurriedly. However, by careful attention to details and by study of the manner in which bees live and work, no one need suffer such a defeat.

Slide 37 (38012-B) Cover page of Farmers' Bulletin 447.

Slide 38 (36878-B) United States Department of Agriculture lantern-slide and film-strip service.

UNITED STATES DEPARTMENT OF AGRICULTURE
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Lecture Notes for Lantern-Slide Series 346

FIRST LESSONS IN BEEKEEPING

By George E. Marvin, Assistant Apiculturist
Bureau of Entomology

This series of 45 slides was prepared from illustrations selected and arranged in cooperation with the Bureau of Entomology. It illustrates standard equipment and a simple, practical method of procedure in handling bees for the production of honey for home use. The series is available for loan from the Division of Cooperative Extension, Extension Service, United States Department of Agriculture, Washington, D. C.

Slide 1 (32269-C) Title.

Slide 2 (38206-B) Credit statement.

Slide 3 (32270-C) Credit statement.

Slide 4 (32271-C) Photograph: Unprofitable box hives. Thousands of colonies of bees in the United States are housed in boxes, nail kegs, or pails. These colonies produce for their owner an insignificant quantity of honey compared with what they might be made to produce if they were in modern hives and handled by improved methods. At the end of the honey flow the bees in the heavy colonies are killed and the combs of honey are cut out, while the lighter colonies are saved to produce swarms the following season, when the heaviest colonies again will be sacrificed. This crude method results in a loss of both honey and bees; in addition, as the lighter colonies are saved, many of the bees die in the winter because of insufficient honey.

Slide 5 (32272-C) Photograph: A modern 1-story hive. The care essential to the production of large crops of honey can be given only to bees in movable-frame hives. The style and size of the hive is not so important as the care that is given to the bees. The standard 10-frame Langstroth hive is the one most commonly used in the United States, and may be purchased from any dealer in beekeepers' supplies. Home-made hives should be carefully patterned after a factory model, and especial attention should be given to exact dimensions.

Slide 6 (32273-C) Photograph: Modern hive cut to show interior. The modern hive usually is made up of a brood chamber or lower story, consisting of a box, without top or bottom, holding 10 frames, each frame enclosing a comb; a food chamber similar to the brood chamber, or shallower like the one in the illustration; an inner cover; a roof or outer cover; and a bottom board. In addition, there are upper stories, or supers, to hold the crop of honey. The supers hold either a set of frames the same

IMPORTANT: This lantern-slide series is available for loan both on film strip and on glass slides.

Note. Underlining indicates that part of series which appears on the screen.

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size as those in the brood chamber or shallower, or comb-honey sections. Between the brood chamber and the supers is a queen excluder, which prevents the queen from depositing eggs in the combs intended for table use, but permits free passage of the worker bees.

Slide 7 (32274-C) Photograph: Equipped with veil, hive tool, and smoker. The use of the movable-frame hive makes it possible for the beekeeper to look into the hive to determine the condition of the bees, an impossibility with the old-fashioned method of keeping bees. Early in the spring, on a bright, warm day when the bees are flying, the hive should be opened and the quantity of stores, the strength of the colony, and the condition of the queen be determined. Later, the hive should again be opened and the progress of the bees noted. To handle bees safely, it is desirable to have a smoker, a hive tool, and a veil. Before a hive is opened, the smoker should be lighted and made to produce cool, white smoke. Pieces of burlap sack, cut-up corncobs, excelsior, or dry pine needles make good fuel. The timid, inexperienced person may have a little trouble in handling bees at first, but with patience and care he should soon become adept.

Slide 8 (32275-C) Photograph: A puff of smoke at the entrance. Thus properly equipped, with a smoker in one hand and a hive tool in the other, one should approach the hive from the side and puff a little smoke at the entrance. The smoke causes the bees on guard at the entrance to rush into the hive and fill themselves with honey, and in this condition they are gentler and thus easier to handle.

Slide 9 (32276-C) Photograph: Smoke under inner cover. The outer cover should be taken off as gently as possible and placed nearby, upside down. Jarring the hive does not improve the temper of the bees. The hive tool should then be inserted under the inner cover to pry it up a little, and a warning puff of smoke applied at the crack. With a twist of the hive tool the cover may then be loosened and more smoke blown over the frames. Too much smoke often causes black or hybrid bees to stampede and to run out of the hive. A very little smoke, at just the right time, will drive back any bees that show signs of attacking. When they alertly stick their heads up in rows between the frames, or stand high on their legs, acting nervous and ready to take wing, they are on guard and need another puff of smoke to send them down. The smoker should not be permitted to go out after the preliminary steps of opening the hive have been taken. If it is properly lighted in the beginning, an occasional puff will insure its being ready for use when needed.

If the food chamber contains no brood, it should be pried loose from the brood chamber with the hive tool and set upon the edges of the inverted hive cover. This avoids crushing the bees that cling to the bottom.

Slide 10 (32277-C) Photograph: Top removed from the brood chamber. With the hive open and the bees quiet, the examination can begin. Care should be taken not to crush or kill any bees or to make quick movements over the hive, as this may arouse the anger of the colony and cause several bees to fly out and attempt to sting. One should always be as

deliberate and composed as possible in manipulating bees, remembering that unless aroused they are not inclined to resent handling.

Slide 11 (32278-C) Photograph: Loosening the first frame. The frames probably will be stuck together with propolis, or bee glue, and will have to be pried apart with the hive tool. The first or second frame on the near side should be loosened, and then the others can be shoved together to give more space for removing it. It is best to start with one of the outside frames, because there are fewer bees on them and there is less likelihood of injuring the queen.

Slide 12 (32279-C) Photograph: Removing the first frame. One frame at a time is lifted out and examined until the queen is found. All frames should be carefully lifted straight up to avoid crushing the bees. Rough handling of a frame at this stage will cause the bees to become angered. The first frame is set on end against one side or the back of the hive, and then the remaining frames are, one after another, moved into the space thus vacated and lifted out for examination. All frames should be replaced in their original order so that the brood nest will not be disarranged. The frame containing the queen should never be set outside the hive, lest she drop off and be lost.

Slide 13 (32280-C) Photograph: Brood frame, covered with bees, showing two queen cells. Often the beginner is not able to distinguish capped honey from capped brood, or drone brood from worker brood. Sealed worker brood is of a light to dark brown color, is made up of wax and fibrous material, and is smooth and slightly convex. Worker brood has 5 cells to the inch. Drone brood has 4 cells to the inch and the cappings are more convex or dome-shaped. The cappings over honey are white, bluish white, or yellow, somewhat rough and irregular, and flattened. All the sealed cells in the illustration are of worker brood.

Pollen or bee bread is found in the cells directly above the brood, and honey is found in the cells near the top bar.

Slide 14 (32281-C) Photograph: Close-up of brood comb. The most important individual in the hive is the queen. Both structurally and in size she is different from the worker bee, although both develop from the same kind of egg. Bee bread is fed to a worker during part of its larval life, but a queen is fed exclusively on a rich, nourishing food called royal jelly. Because of the importance of the queen to the life of the whole colony, it is well to know that she is alive and functioning. The presence of eggs and young larvae indicates that the colony has a queen or has had one within the last 3 days. During spring and summer there should be brood in all stages, as well as eggs.

The egg is a small white object in the bottom of the cell. Several eggs are plainly seen in the left-edge center of the comb illustrated. In 3 days the egg hatches into a pearly white, coiled grub, or larva. It remains in this form for 6 days and is then capped over by the bees. During the next 12 days transformation to the adult bee takes place. In 21 days from the time the egg is laid the adult worker bee emerges. All stages are shown in the illustration.

Slide 15 (32282-C) Photograph: Queen examining cells preparatory to laying eggs. During the manipulation of a colony, it frequently is desirable to locate the queen. One comb after another should be lifted out and examined until the queen is found. Upon removing each frame, one should look first on the face of the next comb as it hangs in the hive and then on both sides of the frame in the hands. The queen usually is found walking about over the comb looking for empty cells or actually laying eggs. She first inserts her head into the cell, then turns about and lowers her abdomen into it, depositing a single egg at the bottom. Usually a ring of worker bees surrounds the queen wherever she is. This retinue of workers clean her body and feed her every few minutes while she is engaged in egg laying.

Slide 16 (32283-C) Photograph: Clipping the wings of the queen. It is good practice to clip the wings on one side of all queens, for this prevents the old queen, when she leaves with the swarm, from taking the bees to some inaccessible place, such as the top of a tall tree. If the beekeeper is away at the time of swarming, the queen, unable to fly, will crawl off in the grass and, although she may become lost, the bees will return to their original hive. The bees will not seek new quarters without a queen.

There are many ways of holding and clipping the queen. In the illustration she is being held by her legs between thumb and forefinger, and a pair of small scissors is being used to clip off most of the larger wing and merely the tip of the smaller wing on one side. In catching and holding a queen care must be taken not to clip off a leg or to injure her in any other way. She should not be clasped by one leg only, as she may twist around and injure herself, or pull herself loose and fly away. Many prefer to hold the queen by the thorax when clipping, instead of by the legs. Others hold her on the comb with a finger or two while cutting her wings. Whatever way is used, one should be careful not to pinch the abdomen, which is soft and often distended with eggs, and easily injured.

Slide 17 (32284-C) Photograph: Embedding wires in foundation. To get good brood combs it is necessary to use either wired foundation or wired frames with full sheets of "medium brood" foundation. The wires are embedded in the wax foundation with a spur embedder, shown in the illustration, or by heating the wires with an electric current, so that they will sink into the foundation of their own accord. The wiring device shown in the illustration facilitates lacing the wires through the end bars in such a manner that they can be drawn taut.

Slide 18 (32285-C) Photograph: Poor brood comb: no foundation used. In combs that have been built without foundation, many of the cells near the top bar are stretched out of shape and many drone cells appear on the sides and bottom. Frequently the brood capacity of a hive is cut down a third, or even a half, by the use of such imperfect combs. This results in weak or less than full-sized colonies, and consequently in a distinct loss to beekeepers. For a comb built without foundation, the one illustrated is better than the average.

If the brood nest contains defective combs or combs containing much drone brood, such combs should be replaced with good combs or foundation. If this is not feasible, the defective combs should be shifted towards the side walls of the hive, where they are not so likely to be used for brood rearing.

Slide 19 (32286-C) Photograph: A good brood comb built on wired foundation. The importance of having good worker combs in the brood nest cannot be overemphasized. Such a comb, filled almost solidly to the top bar with sealed worker brood, is illustrated here. A few cells of honey can be seen in the two top corners, but it is about as good a frame of brood as one could wish for. This comb also well illustrates the work of a good queen.

Slide 20 (32287-C) Photograph: Swarm on limb removed from tree. When bees swarm, it is the old queen and most of the old bees that leave the parent hive. The queen and the bees usually settle on a limb of a tree near the apiary, where they may remain a few minutes or several hours, depending on weather conditions and how soon the scouts succeed in finding a new abode. Here we see a clustered swarm cut from a tree and ready to be placed in a new hive.

Slide 21 (32288-C) Photograph: Preparing to hive the swarm. If the swarm has settled on a limb that can be cut off conveniently, the whole cluster can be carried to any part of the apiary and hived. In performing this operation the bees should not be jarred. Frequently, the bees cluster in such a position that the swarm cannot be cut off. In this event a burlap sack can be slipped over the swarm and the bees shaken into it. The sack of bees can then be emptied in front of a hive. It is sometimes possible to place a sheet on the ground under a swarm and to place an empty hive on the sheet so that when the cluster is jarred suddenly the bees will fall directly in front of the entrance. After the bees have entered the hive, they should be left undisturbed until nightfall, when the hive can be moved to a permanent location. The hive in which the swarm is placed should be equipped with full sheets of foundation or with drawn combs.

Slide 22 (32289-C) Photograph: Swarm entering the hive. If the hive is acceptable to the bees, they will readily adopt it as their new home when shaken in front of the entrance. It often is possible to catch the queen as she is entering. Her wings can then be clipped and she can be placed in the entrance. Hives that are too hot or otherwise not acceptable to the bees will be deserted.

Slide 23 (32290-C) Photograph: Package of bees about to be installed in a hive. This illustration shows another way of starting a colony of bees. Packages containing 2 or 3 pounds of bees and a queen are obtainable from southern breeders. The best time for a package to be installed is during dandelion and fruit bloom. A package received later, at the beginning of the main flow, should build up a strong colony before winter, but it will not produce a crop of honey until later.

Slide 24 (32291-C) Photograph: Installing a package of bees. The package is inserted in the hive after a sufficient number of frames have been removed.

Photograph:
Slide 25 (32292-C)/ Releasing bees and queen. The small, square piece of wood directly above the feeder in the package is removed and the feeder can lifted out. The queen cage should next be lifted out and, if the queen is alive and in good condition, the small piece of cardboard over the candy plug should be removed and the cage placed, wire down, on the frames. In a day or two the bees will release the queen. The bees will crawl out of the shipping cage and take up a position on the frames, where they will start to work almost immediately.

Slide 26 (32293-C) Photograph: Feeding released bees. An inner cover is put in place and a can of sugar sirup is inverted over the hole in the cover. The feeder can is a 5- or 10-pound friction-top pail in the cover of which holes have been made with a lath nail, from the outside in, so that they will be smooth on the outside. The sirup consists of 2 parts of granulated sugar to 1 part of water by volume. The temperature of the mixture is raised until the sugar is all dissolved. Care should be taken not to scorch the sirup.

Slide 27 (32294-C) Photograph: Removing the empty cage. The empty cage can be removed within a day or two after the package has been installed. If the cage still contains some bees, it should be shaken in front of the hive.

Slide 28 (32295-C) Photograph: Inserting frames with foundation. In the space from which the cage was removed frames with full sheets of foundation should be inserted. A colony will build up rapidly if it is fed sufficiently and if the weather is favorable for the bees to fly and gather pollen.

Slide 29 (32296-C) Package built up to full strength. Just before the bees have filled out the 10 frames in the brood chamber, a shallow super, also containing 10 frames, should be put on. As the bees become crowded in the lower chamber, they will move up into this super. One cannot expect any surplus honey until the colony is strong enough to occupy these two chambers.

Slide 30 (32297-C) Photograph: Inserting foundation for table honey. For the beekeeper with a small number of colonies, who produces honey for his own use or for limited sale, it is most convenient to use shallow frames. The bees usually produce more honey in this way than when they are managed for the production of comb-section honey. Furthermore, the swarm-control problem is much less serious. Not until one has become proficient in handling bees and is able to produce honey in shallow frames satisfactorily should one expand into comb-section honey production.

Here we see "thin surplus" foundation being inserted in the frames. Each sheet is pressed down into the slot in the top bar and is fastened with melted wax. With a little practice one soon knows at what temperature to heat the wax so that it will solidify quickly and not melt the foundation.

Slide 31 (32298-C) Photograph: Queen excluder being placed on the brood chamber. When the colony is fully occupying the two stories and there still are nectar-producing flowers available, it is advisable to add supers for

the storage of surplus honey. Several supers, each containing 10 frames, should be prepared for each colony. After making sure that the queen is in the brood chamber, the food chamber is removed and a queen excluder is placed above the brood nest.

Slide 32 (32299-C) Photograph: Supers above excluder, food chamber on top. Two supers are placed on the queen excluder and the food chamber is placed on top. As any brood that may be in the food chamber hatches, the bees will fill the cells with honey and draw out the foundation in the two supers. As the season advances and it is found that the bees need more room, more supers can be added next to the queen excluder.

Slide 33 (32300-C) Photograph: Brushing bees from frame of honey. There are several ways of removing the honey from the hives. The simplest method is to lift out a frame of honey and brush the bees off the comb with a soft brush. Some smoke may be needed to quiet the bees.

Slide 34 (32301-C) Photograph: A bee-escape board. By the use of a bee escape one is able to take off honey without receiving a sting or killing any bees. A bee escape is a small contrivance which fits snugly into a hole in an inner cover. It has two sets of yielding springs, providing an exit for the bees but not permitting them to enter the super. An inner cover with a bee escape constitutes a bee-escape board. It is placed under the supers of honey that are to be removed. Within 2 or 3 days all the bees will have passed downward to the brood chamber and the super can be taken away. This method may not always work smoothly, for occasionally a bee will get into the entrance and die, stopping it up. If it is found, after the proper length of time, that all the bees have not left the super, it probably will be necessary to clear out the bee escape.

Slide 35 (32302-C) Photograph: Removing honey where a bee-escape board is used. In this instance the super immediately under the food chamber, being the first super put on, was filled with honey and was to be removed. The bee-escape board was placed underneath it, and in 2 days the super was emptied of all bees.

Slide 36 (32303-C) Photograph: Cutting comb from the frame. One attractive form in which the honey crop is marketed is cut-comb honey, which is shallow-frame comb honey cut into blocks and wrapped in cellophane. The cutting should be done in a warm room as soon as possible after the honey is removed from the hive.

Slide 37 (32304-C) Photograph: Cutting and draining shallow-frame comb honey. After the frame has been lifted off, the large piece of comb is cut into the desired sizes and the blocks are separated so that the cut edges can be drained. Blocks of wood the size of the cut squares of honey should be placed under the honey before it is cut.

Slide 38 (32305-C) Photograph: Wrapping shallow-frame cut-comb honey. After the pieces of comb have been thoroughly drained, they can be wrapped in cellophane and sealed, so that if any honey should leak from the comb

it will not escape from the package. Attractive cardboard cartons to hold these wrapped combs are now on the market. These cartons protect the honey and yet have a window through which the honey is plainly visible.

Slide 39 (32306-C) Photograph: Fall manipulation. When the fall honey flow is ended, the queen excluder and any remaining supers should be removed, and only the food chamber left on top of the brood nest.

Slide 40 (32307-C) Photograph: Feeder tipped, showing holes in cover. If, in the fall, a colony is found to be light in stores - that is, to have less than 30 pounds of honey - and if full combs of honey are not available form other colonies, the winter stores can be supplemented with sugar sirup supplied in the same manner as in feeding package bees. This view shows the distribution of the nail holes in the feeder.

Slide 41 (32308-C) Photograph: Feeder in place. This shows the feeder in place. To protect the feeder, an empty super should be added and the hive closed tightly with an inner and an outer cover. Feeding for winter stores should be done just as fall brood rearing comes to an end.

Slide 42 (32309-C) Photograph: Uniting colonies by the paper method. It is poor economy to attempt to nurse along, in either the fall or the spring, weak colonies which will not survive the winter or will not build up in time to collect a surplus. A weak colony should be united with a strong one, never with another weak one. To do this, a sheet of paper should be placed above the brood chamber of the strong colony and 2 or 3 small holes, not large enough to permit a bee to crawl through, punched in it. The weak colony should then be removed from its bottom board and placed on top of the strong colony. This is preferably done in the evening, after all the bees are in their hives. In a day or so - by the time the bees have gnawed through the paper - the bees will have united peaceably. If more than one queen is present, they will fight until only one survives.

Slide 43 (32310-C) Photograph: Small apiary packed for northern winter. In apiaries situated north of the latitude of Washington, D. C., it usually is necessary to pack the hives for winter. This picture shows an apiary with the hives in groups of two packed with wood shavings and tar paper. The board fence has been erected for a windbreak. Two hives are shoved together and placed on a well-insulated stand, and a tunnel is arranged from the entrance of each hive to the edge of the stand. The hives are first wrapped loosely with tar paper and the space between the hives and the tar paper is filled with shavings. The tar paper has been nailed to the hive stand and the free edges are folded over the tops of the hives. Another sheet of tar paper is placed on top and tied down with twine.

Slide 44 (32311-C) Photograph: A small apiary in a wind-sheltered location. Success in wintering depends more upon having strong colonies of young bees with plenty of honey of good quality than upon protection from inclement and cold weather. Packing helps, however, and so does protection from the wind. Here is an apiary well protected by a natural windbreak.

Slide 45 (36878-B) United States Department of Agriculture lantern-slide and film-strip service, Washington, D. C.



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